Volume I, Technical and Management Proposal

(1) BAA number:	DARPA-BAA-12-03
(2) Technical area:	Technical Area 1 – Narrative Analysis Technical Area 2 – Narrative Neurobiology
(3) Lead Organization submitting proposal:	Arizona Board of Regents on behalf of Arizona State University
(4) Type of business:	Other educational
(5) Contractor's reference number:	12040772
(6) Other team members and type of business for each:	St. Joseph's Hospital and Medical Center, Other Nonprofit
(7) Proposal title:	Toward Narrative Disruptors and Inductors: Mapping the Narrative Comprehension Network and its Persuasive Effects
(8) Technical point of contact to include:	Dr. Steven Corman [redacted]
(9) Administrative point of contact to include:	Ms. Avery Wright [redacted]
(10) Total proposed cost separated by basic award and option(s):	Basic award cost (Phase 1 and 2) $4,138,258 Option Phase 3 $1,943,364
(11) Date proposal was submitted:	November 22, 2011

SMALL BUSINESS, VETERAN-OWNED SMALL BUSINESS, SERVICE-DISABLED VETERAN-OWNED SMALL BUSINESS, HUBZONE SMALL BUSINESS, SMALL DISADVANTAGED BUSINESS, & WOMEN-OWNED SMALL BUSINESS
SUBCONTRACTING PLAN

DATE: November 22, 2011

Contractor: Arizona State University

Address: Administration Building, B Wing
PO Box 873505
Tempe, AZ 85287-3505

Solicitation or Contract Number: DARPA BAA 12-03
(ASU 12040772)

Total Amount of Contract (Including Options): $6,081,622

Period of Contract Performance: 04/01/12 – 09/30/16

1. TYPE OF PLAN (Check One)

X A. **Individual Plan** -Individual Contract Plan, as used in this subpart, means a subcontracting plan that covers the entire contract period (including option periods), applies to a specific contract, and has goals that are based on the offeror's planned subcontracting in support of the specific contract, except that indirect costs incurred for common or joint purposes may be allocated on a prorated basis to the contract.

B. **Master Plan** - Master Plan, as used in this subpart, means a subcontracting plan that contains all of the required elements of the individual plans, except goals, and may be incorporated into individual contract plans, provided the master plan has been approved.

C. **Commercial Products Plan** -Commercial Plan, as used in this subpart, means a subcontracting plan that covers the offeror's fiscal year and that applies to the entire production of commercial items sold by either the entire company or a portion thereof (e.g., division, plant, or product line). The contractor must provide a copy of the approved plan.

2. GOALS

State separate dollar and percentage goals for small, veteran-owned small, service-disabled/veteran-owned small, small disadvantaged, women-owned small and HUB Zone small business concerns as subcontractors, for the basic and each option year, as specified in FAR 19.704.

A. Total estimated dollar value of all planned subcontracting, i.e., with all types of concerns under this contract, is **$956,307**

B. Total estimated dollar value and percent of planned subcontracting with small businesses (small, veteran-owned small, service-disabled/veteran - owned small, small disadvantaged, women-owned small and HUB Zone small business): (% of "A"): **$139,191 and 14.6%**

C. Total estimated dollar value of all planned subcontracting with small businesses (% of "A"): **$60,391 and 6.3%**
Story editor (video presentation)
Computer technical assistance/support

D. Total estimated dollar value of all planned subcontracting with veteran owned small businesses (% of B): **$11,250 and 8.1%**
Printing (poster boards, technical reports)

E. Total estimated dollar value of all planned subcontracting with service disabled/veteran-owned small businesses (% of "B"): **$0**

F. Total estimated dollar value and percent of planned subcontracting with small disadvantaged businesses: (% of "A"): **$7,550 and 0.8%**
Travel planner (commission estimate, 5% of travel budget)

G. Total estimated dollar value and percent of planned subcontracting with women-owned small businesses: (% of "A"): **$60,000 and 6.3%**
Performers (live action and voice over)

H. Total estimated dollar value and percent of planned subcontracting with HUB Zone small businesses: (% of "A"): **$0.**

I. Total estimated dollar value and percent of planned subcontracting with LARGE BUSINESS (% of "A"): **$611,174 and 64%**
Technical expertise and services (St. Joseph's Hospital and Medical Center)
scientific instruments (capital equipment)
computers (Dell, Apple), software, and accessories
video equipment and accessories

J. Provide a description of all the products and/or services to be subcontracted under this contract, and indicate the types of businesses supplying them; (i.e., SMALL BUSINESS (SB), SMALL VETERAN-OWNED SMALL BUSINESS (VOB), SMALL SERVICE· DISABLEDNETERAN-OWNED BUSINESS (SDVOB) , SMALL DISADVANTAGED BUSINESS (SDB), WOMEN-OWNED SMALL BUSINESS (WOSB), LARGE BUSINESS (LB), HUB ZONE SMALL BUSINESS (HUBZONE). (Check all that apply)

See table page 11

K. Description of the method used to develop the subcontracting goals

Owned small, service-disabled/veteran-owned small, small disadvantaged, women-owned small and HUB Zone small business concerns (i.e., explain the method and state the quantitative basis (in dollars) used to establish the percentage goals, in addition to how the areas to be subcontracted to small, veteran-owned small, service-disabled/veteran-owned small, small disadvantaged, women-owned small and HUB Zone small business were determined, and how the capabilities of small, veteran-owned small, service-disabled/veteran owned small, small disadvantaged, women-owned small and HUB Zone small business were determined—include any source lists used in the determination process).

Reviewed budget and deducted from total budget: ASU allocations for labor costs, research subject pay, 95% of travel costs, indirect costs; technical collaborator's budget; and costs of scientific instruments and technical equipment/commodities. Identified areas where small business dollars could be spent. Used Pro net and resources of University's Supplier Diversity Program to find small businesses for contract.

L. Indirect costs have been_____ have not been __X__ included in the dollar and percentage subcontracting goals stated above. (Check one)

M. If indirect costs have been included, explain the method used to determine the proportionate share of such costs to be allocated as subcontract to small, veteran-owned small, service-disabled/veteran-owned small, small disadvantaged, women-owned small and HUB Zone small businesses.

3. PROGRAM ADMINISTRATOR

Name, title, position within the corporate structure, and duties and responsibilities of the employee who will administer the contractor's subcontracting program.

Name: Chester R. Yancy

Title: Manager of Small Business & Diversity Initiatives

Address: [redacted]

Telephone: [redacted]

Duties: Has general overall responsibility for the contractor's subcontracting program, i.e., developing, preparing and executing subcontracting plans and monitoring performance relative to the requirements of this particular plan. These duties include, but are not limited to, the following activities:

A. Developing and promoting company-wide policy initiatives that demonstrate the company's support for awarding contracts and subcontracts small, veteran-owned small, service-disabled/veteran-owned small, small disadvantaged, women-owned small and HUB Zone small businesses; and ensure that small, veteran-owned small, service disabled/veteran-owned, small disadvantaged, women-owned small and HUB Zone small businesses are included on the source lists for solicitations for products and services they are capable of providing.

B. Developing and maintaining bidder's lists of small, veteran-owned small, service-disabled/veteran-owned small, small disadvantaged, women owned small and HUB Zone small business concerns from all possible sources.

C. Ensuring periodic rotation of potential subcontractors on bidder's lists.

D. Ensuring that procurement "packages" are designed to permit the maximum possible participation of small, veteran-owned small, service disabled/veteran-owned small, small disadvantaged, women-owned small and HUB Zone small business concerns within State Purchasing Laws and Regulations.

E. Make arrangements for the utilization of various sources for the identification of small, veteran-owned small, service-disabled/veteran - owned small, small disadvantaged, women-owned small and HUB Zone small business concerns such as the SBA's Procurement Marketing and Access Network Pro-Net, the National Minority Purchasing Council Vendor Information Service, the Office of Minority Business Data Center in the Department of Commerce, National Association of Women Business Owner vendor Information Service, and the facilities of local small business, minority and women associations, and contact with Federal agencies' Small Business Program Managers.

F. Overseeing the establishment and maintenance of contract and subcontract award records.

G. Attending or arranging for the attendance of company counselors at Small Business Opportunity Workshops, Minority and Women Business Enterprise Seminars, Trade Fairs, Procurement Conferences, etc.

H. Ensure small, veteran-owned small, service-disabled/veteran-owned small, small disadvantaged, women-owned small and HUB Zone small business concerns are made aware of subcontracting opportunities and how to prepare responsive bids to the company.

I. Conducting or arranging for the conducting of training for purchasing personnel regarding the intent and impact of Public Law 95-507 on purchasing procedures.

J. Monitoring the company's performance and making any adjustments necessary to achieve the subcontract plan goals.

K. Preparing and submitting (in a timely manner) the required subcontract reports.

L. Coordinating the company's activities during the conduct of compliance reviews by Federal agencies.

M. Reviewing solicitations to remove statements, clauses, etc., which may tend to restrict or prohibit small, veteran-owned small, service disabled/veteran-owned small, small disadvantaged, women-owned small and HUB Zone small business concerns participation, where possible.

N. Ensuring that the company documents its reasons for not selecting low bids submitted by small, veteran-owned small, service-disabled/veteran owned small, small disadvantaged, women-owned small and HUB Zone small business concerns.

O. Ensuring the establishment and maintenance of records of solicitations and subcontract award activity.

P. Ensuring that historically Black colleges and universities and minority institutions shall be afforded maximum practicable opportunity (if applicable).

Q. Other duties: Manages Arizona State University Supplier Diversity Program

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4. EOUITABLE OPPORTUNITY

The contractor agrees to ensure that small, veteran-owned small, service disabled/veteran-owned small, small disadvantaged, women-owned small and HUB Zone small business concerns will have an equitable opportunity to compete for subcontracts. The various efforts include, but are not limited to, the following activities:

A. Outreach efforts to obtain sources:

(i) Contacting small, veteran-owned small, service-disabled/veteran owned small, small disadvantaged, women-owned small and HUB Zone small business trade associations (identify specific small, veteran-owned small, service-disabled/veteran owned small, small disadvantaged, women-owned small and HUB Zone small business trade associations).

University is active member of Grand Canyon Minority Business Development Council, Women's Business Development Center

(ii) Contacting small business development organizations (identify specific small business development organizations).

Small Business Administration. Women's Business Development Center, Grand Canyon Minority Business Development Council Great Phoenix Chamber of Commerce.

(iii) Attending small, veteran-owned small, service-disabled/veteran owned small, small disadvantaged, women-owned small and HUB Zone small business procurement conferences and trade fairs (to the extent known, identify specific procurement conferences and trade fairs referencing dates).

Participate and have booths at the Grand Canyon Minority Supplier Development Council, National Center for American Enterprises Development Center, Reservation Economic Summit in Las Vegas and other trade show in Arizona.

(iv) Potential sources will be requested from SBA's Pro-Net System.

(v) Utilizing newspaper and magazine ads to encourage new sources.

B. Internal efforts to guide and encourage purchasing personnel:

(i) Presenting workshops, seminars, and training programs.

Establishing, maintaining, and using small, veteran-owned small, service-disabled/veteran-owned small, small disadvantaged, women-owned small and HUB Zone small business source lists, guides and other data for soliciting subcontracts.

(iii) Monitoring activities to evaluate compliance with the subcontracting plan.

C. Additional efforts: University's Supplier Diversity Program, Annual Supplier Diversity Conference held in October, Diverse Supplier Vendor Show for University buyers held in May.

5, FLOW-DOWN CLAUSE

The contractor agrees to include the provisions under FAR 52.219-8, "Utilization of Small Business Concerns, small, veteran-owned small, service disabled/veteran-owned small, small disadvantaged, women-owned small and HUB Zone small business concerns" in all subcontracts that offer further subcontracting opportunities. All subcontractors, except small business concerns, that receive subcontracts in excess of $550,000 ($1,000,000 for construction) must adopt and comply with a plan similar to the plan required by FAR 52.219-9, "Small Business Plan." (FAR 19.704 (a) (4»

Such plans will be reviewed by comparing them with the provisions of Public Law 95-507, and assuring that all minimum requirements of an acceptable subcontracting plan have been satisfied. The acceptability of percentage goals shall be determined on a case-by-case basis depending on the supplies/services involved, the availability of potential small, veteran-owned small, service-disabled/veteran-owned small, small disadvantaged, women-owned small and HUB Zone small business subcontractors, and prior experience. Once approved and implemented, plans will be monitored through the submission of periodic reports, and/or, as time and availability of funds permit, periodic visits to subcontractor's facilities to review applicable records and subcontracting program progress.

6. REPORTING AND COOPERATION

The contractor gives assurance of (I) cooperation in any studies or surveys that may be required by the contracting agency or the Small Business Administration; (2) submission of periodic reports which show compliance with the subcontracting plan; (3) submission of Standard Form (SF) 294, "Subcontracting Report for Individual Contracts," and SF-295, "Summary Subcontract Report," in accordance with the instructions on the forms; and (4) ensuring that large business subcontractors with subcontracting plans agree to submit Standard Forms 294 and 295.

Reporting Period	Report Due	Due Date
Oct 1 –Mar 31	ISR (eSRS)	04/30
Apr I -Sep 30	ISR (eSRS)	10/30
Oct I -Sep 30	ISR (eSRS)	10/30

7. RECORDKEEPING

The following is a recitation of the types of records the contractor will maintain to demonstrate the procedures adopted to comply with the requirements and goals in the subcontracting plan. These records will include, but are not limited to, the following:

A. If the prime contractor is not using Pro-Net as its source for small, veteran owned small, service-disabled/veteran-owned small, small disadvantaged, women-owned small and HUB Zone small business concerns, list the names of guides and other data identifying such vendors.

B. Organizations contacted in an attempt to locate small, veteran-owned small, service-disabled/veteran-owned small, small disadvantaged, women-owned small and HUB Zone small business sources.

C. On a contract-by-contract basis, records on all subcontract solicitations over $100,000 which indicate for each solicitation (1) whether small business concerns were solicited, and if not, why not; (2) whether veteran-owned small business concerns were solicited, and if not, why not;

(3) whether service-disadvantaged veteran-owned small business concerns were solicited, and if not, why not; (4) whether small disadvantaged business concerns were solicited, and if not, why not; (5) whether women-owned small businesses were solicited, and if not, why not; (6) whether HUB Zone small businesses were solicited, and if not, why not, and (7) reason for failure of solicited small, veteran-owned small, service-disabled/veteran-owned small, small disadvantaged, women owned small and HUB Zone small business concerns to receive the subcontract award.

D. Records to support other outreach efforts, e.g., contact with minority, Small, and HUB Zone small business trade associations, attendance at Minority and women-owned small business procurement conferences and trade fairs.

E. Records to support internal guidance and encouragement, provided to buyers through (1) workshops, seminars, training programs, incentive awards; and (2) monitoring of activities to evaluate compliance.

F. On a contract-by-contract basis, records to support subcontract award data including the name, address and business size of each subcontractor. (This item is not required for company or division-wide commercial products plans.)

G. Additional records: The University produces an annual report of spending in Illinois with minority-owned, woman-owned businesses, and local.

This subcontracting plan was submitted by:

Signature: [redacted]

Typed Name:
Title:

Date Prepared: 11-22-11
Phone No.: [redacted]

Approval:
Agency: _____

Typed Name: _____

Title: _____

Signature: _____

Date Prepared: _____

Phone No.: _____

Continuation page:

Section 2.J Description of all products and/or services to be subcontracted under this contract and indicate the types of businesses supplying them.

Subcontracted Product/Service	**SB**	**VOB**	**SDVOB**	**SDB**	**WOSB**	**HUBS**	**LRG.**
Performers/actors	**X**	**X**			**X**		
Story editor	**X**	**X**	**X**	**X**	**X**		
Printing	**X**	**X**	**X**	**X**	**X**	**X**	
Computer tech/assist		**X**		**X**	**X**		
Travel	**X**						
Scientific instruments							**X**
Computers, software, accessories	**X**	**X**			**X**		**X**
Video equipment, accessories	**X**	**X**			**X**		**X**
Technical expertise							**X**

II.A. INNOVATIVE CLAIMS

Humans are storytelling beings. There is no clearer evidence of this than the struggles of the United States government to convince world populations of its good intentions, and to dissuade key constituencies from the powerful narratives told by violent extremists. In short, it is widely recognized that the U.S. is "losing the battle of the narrative" and thus, consequentially, the "war of ideas". This project responds to Technical Areas 1 and 2, with the aim of revolutionizing the study of the neuropsychology of narrative and its effects on persuasion. It will generate the knowledge to effectively understand, model, and disrupt *narratives*—systems of stories sharing themes, forms, and archetypes—on a neurological level, and the capability to induce powerful narrative phenomena (such as transportation and narrative validity) with certainty. To achieve this goal we have assembled a transdisciplinary team from Arizona State University and the Barrow Neurological Institute. Members have expertise in neuropsychology, neuroimaging, narrative theory, persuasion and strategic communication, as well as religion and culture. The team will achieve four key innovations in research approach, theory, and practice.

Integrate narrative theory, neuroimaging, and persuasive outcomes. Each of these areas has been studied independently, but no effort to date has tested responses of the brain to narrative, and correlated those to attitude and behavior change. Our design integrates these concepts in all three project phases, meaning that the neural underpinnings of narrative can be directly linked to practical strategic communication outcomes.

Resolve conceptual problems in narrative and psychology of religion. Most narrative theory comes from humanities, which favors interpretive analysis of single narratives (or small sets thereof), and tends to discount generalizable, quantitative, empirical research.
Further, studies of the psychology of religion have historically been based on a “measurement paradigm” that takes little account of narrative structure of religious messages. This project tests key narrative theories from communication, literary studies, and psychology in a design that will explain relative effects. It also uses stimuli based on religious master narratives—so often appropriated by extremist groups—to understand the psychological effects of particular message features and to attend to the relationship between narrative and political violence in contested populations, a small subset of which may engage in extremist behavior or financially, ideologically, or politically support extremists.

Produce significant innovations in the study of the neuropsychology of narrative. While some research exists on how particular brain regions respond to narrative, none has identified brain *networks* that are responsible for narrative comprehension. This is a key shortcoming because the activity of any particular region is affected in complex ways by activity in other regions. Existing research also relies on fMRI methods that achieve poor temporal resolution. This prevents full understanding of how various regions work together over time to comprehend a narrative. Only by taking a holistic, multi-modal neuroimaging approach can we fully understand how narrative affects the brain.

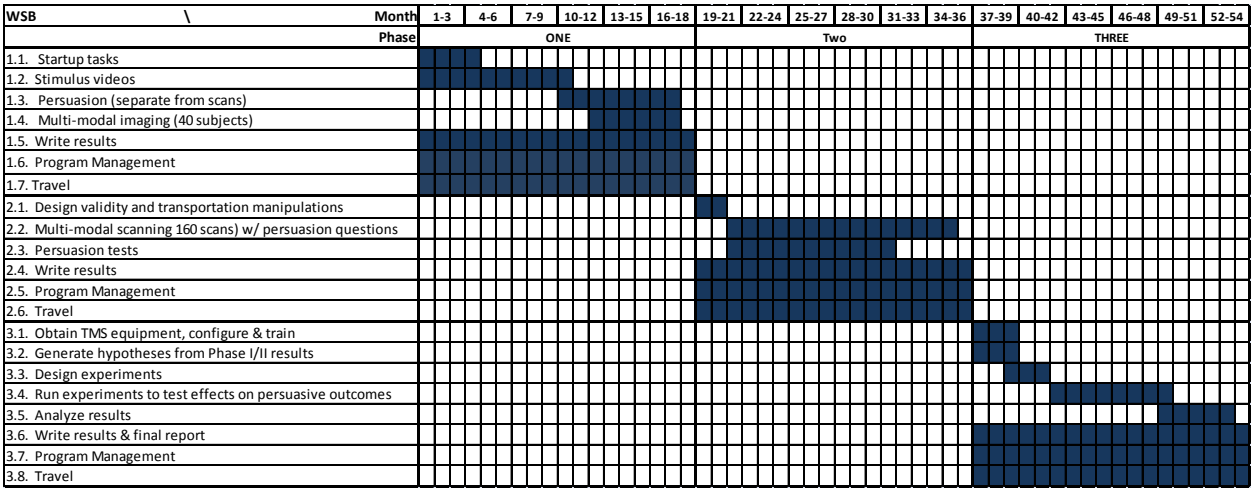
Generate practical innovations. Strategic communicators face numerous questions with regard to narrative. Does grounding a message in a master narrative make a practical difference in persuading members of an audience? If it does, can the effect be enhanced by ensuring that listeners are transported into a story? If the narrative is circulating in a population, can it be degraded by circulating elements that reduce its coherence? Answers to these questions, which this project will provide, are key to identifying disruptors and inductors that can make narrative-based strategic communication more effective.

II.B. DELIVERABLES

Our research fundamentally develops the capacity to disrupt cognitive narrative processes to alter their persuasive power and further establishes a methodology for inducing narrative validity, transportation and integration in strategic communication messaging. To deliver this capability our project will produce: A model of the Narrative Comprehension Network, correlations between narrative theory and brain function, a validated experimental paradigm for future research to follow, and a development plan for narrative disruptors and inductors.
A summary of the projects deliverables includes:

- **A validated experimental paradigm.** The research proposed herein will establish an experimental paradigm for investigating narrative theory at multiple levels of analysis including behavioral, cognitive, and biological. This paradigm and associated stimulus materials will not only support this project but future research on the neuropsychology of narrative.
- **A map of the Narrative Comprehension Network.** This network will reflect an interconnected set of brain regions that support narrative comprehension through the coordination of cognitive mechanisms such as attention, memory, identity, and theory of mind. Mapping the influence of attention, memory, identity, emotion, and theory of mind will address technical area 2 sub-goals 2, 3, and 5 by clarifying the shared contributions of these neural networks to narrative comprehension. Because of the multi-modal approach described in Section III, this map will not only describe the connections between brain regions, but information about how they sequence in a temporal fashion to respond to narrative stimuli.
- **A correlational model of the relationship between the Narrative Comprehension Network and theories of vertical integration, narrative transportation and narrative validity.** Narrative theories are typically studied and discussed in isolation. Our work both productively elucidates the overlap of these theories and, importantly, relates them to brain processes and functions.
- **Data for modeling narrative comprehension.** The proposed research will provide strong empirical constraints for informing and modeling biological and behavioral aspects of strategic communication as it relates to narrative.
- **Mechanisms for Narrative Induction & Disruption:** This project will result in an empirical basis upon which to craft strategic communication materials such that their introduction into a discourse system should induce a higher rate of narrative validity, transportation, and vertical integration. The Narrative Comprehension Network model will provide the basis for pre-testing such materials to ensure they activate the appropriate neural network components to maximize narrative induction. These same efforts will identify underlying mechanisms to disrupt narrative processing in the brain. We will have a thorough understanding of the neural and persuasive effects of manipulating narrative transportation, narrative validity and vertical integration.

II.C. COST, SCHEDULE AND MILESTONES



<u>Phase 1 April 2012 (Month 1) – September 2013 (Month 18) $2,303,195</u>

- Complete project preparation and experiment design by Month 4. $340,981
- Internal report about Narrative stimuli is ready by Month 4. Also, internal report on video production is available by Month 10. $657,495
- Pretest, run and analyze persuasion protocol testing – Completed manuscripts will be submitted to conferences and for publication by Month 17. $253,202
- Pretest, run and analyze Multi-modal imaging scanning protocol testing – Date collected will be analyzed by Month 17. $266,051
- Phase One project progress report is ready by Month 18. $475,313
- Monthly progress report starting from Month 1 to Month 18. $224,527
- Attend Kick-off meetings, PI annual meetings and conferences. $85,626

<u>Phase 2 October 2013 (Month 19) – March 2015 (Month 36) $1,835,062</u>

- Design manipulations by Month 20. $84,576
- Recruit subjects, pretest, run and analyze EEG and FMRI imaging scanning. Group analyses will be performed by Month 35. $730,032
- Recruit subjects, pretest, run and analyze results for Persuasion Tests in according with EEG/fMRI by Month 31. $373,559
- Phase Two project progress report will be produced by Month 36. $350,646
- Monthly progress report starting from Month 19 to Month 36. $236,472
- Attend PI annual meetings and conferences. $59,777

<u>Phase 3 April 2015 (Month 37) – September 2016 (Month 54) $1,943,364</u>

- Obtain TMS hardware and set up by Month 39. $179,943
- Generate hypotheses by Month 39. $141,058
- Design experiments by Month 41. $186,948
- Conduct experiments by Month 49. $380,294
- Analyze experiment results by Month 53. $370,726
- Phase Three project progress report will be ready by Month 54. $347,113
- Monthly progress report starting from Month 37 to Month 54. $252,422
- Attend PI annual meetings and conferences. $84,860

II.D. TECHNICAL RATIONALE AND APPROACH

This project investigates cognitive activity and narrative in the context of persuasive rhetoric in a multidisciplinary manner that significantly advances the knowledge base of neuroscience, narrative studies, and social and cognitive psychology. A critical goal of the project is to provide a precise understanding of the role narrative plays in encouraging individuals to support or participate in political violence and be subject to extremist recruitment.

One key advantage of this proposal is the testing of the vertical integration paradigm that can be used to investigate neural networks. This addresses TA 1 Sub-goal One, to develop new and extend existing narrative theories. It also addresses TA 2 Sub-goal Two, Three, and Five, understanding narrative impact on neurobiology of learning, memory, and identity; narrative impact on neurobiology of emotion; and narrative impacts on neurobiological bases of theory of mind.

In brief, participants will view a series of video vignettes that either map or do not map local narratives onto a master narrative framework drawn from their religious affiliation (Christian or Muslim). After viewing the local narrative video participants will either engage in cognitive activity to identify with the narrative (i.e., self imagery designed to invite participants to cast themselves in personal narrative, which engages theory of mind) or to evaluate the message of narrative (i.e., semantic processing but not personal narrative mapping). Finally, participants' attitudes and behaviors will be measured to assess how vertical integration influences beliefs and persuasion. This experimental paradigm can be implemented both inside and outside of a multimodal neuroimaging environment to assess the effects of narrative on attitudes and behavior and on brain functioning with high temporal (EEG) and spatial resolution (fMRI).

In Phase 1, we will quantitatively validate our narrative paradigm, record multi-modal neuroimaging responses to narrative, and quantify behavioral outcomes. Using these multi-modal imaging techniques will allow us to identify the network of brain regions (Narrative Comprehension Network) as well as allow us to specify how it operates. This is necessary because of confirmation bias that is inherent in brain imaging studies To accomplish this outcome, we will employ neuroimaging techniques with high spatial (fMRI) and temporal (EEG) resolution.

In Phase 2, we will manipulate theoretically and empirically (from Phase 1) derived aspects of narrative validity and transportation to influence vertical integration and persuasion, with directed tests of the effects on neuropsychological processing.

In Phase 3, we will selectively alter aspects of narrative structure and brain functioning via Transcranial Magnetic Stimulation (TMS) to induce or disrupt selective features of narrative processing, to provide the strongest possible inferences about the operation of the Narrative Comprehension Network. Nodes selected will be those that (a) can be accessed and safely manipulated via TMS, and (b) occupy the most critical positions in the network, and (c) are associated with the strongest effects in Phases I and II. This will help establish causal effects of the network identified.

Overall, this research program will provide important insights into the emergence or support of political violence and help clarify the role of strategic communication in mitigating it (addressing TA 1 Sub-goal Two, to determine how narratives influence political violence). We will accomplish these goals by integrating insights from a number of disciplines represented by our research team.

II.E. OTHER RESEARCH IN THIS AREA

This project integrates insights from three theoretical terrains: (1) narrative networks in circulation in contemporary cultures; (2) brain networks or the neural and cognitive pathways through which the brain processes narrative as measured by multi-model brain imaging techniques; and, (3) meaning networks or the patterns of interpretation and persuasion.

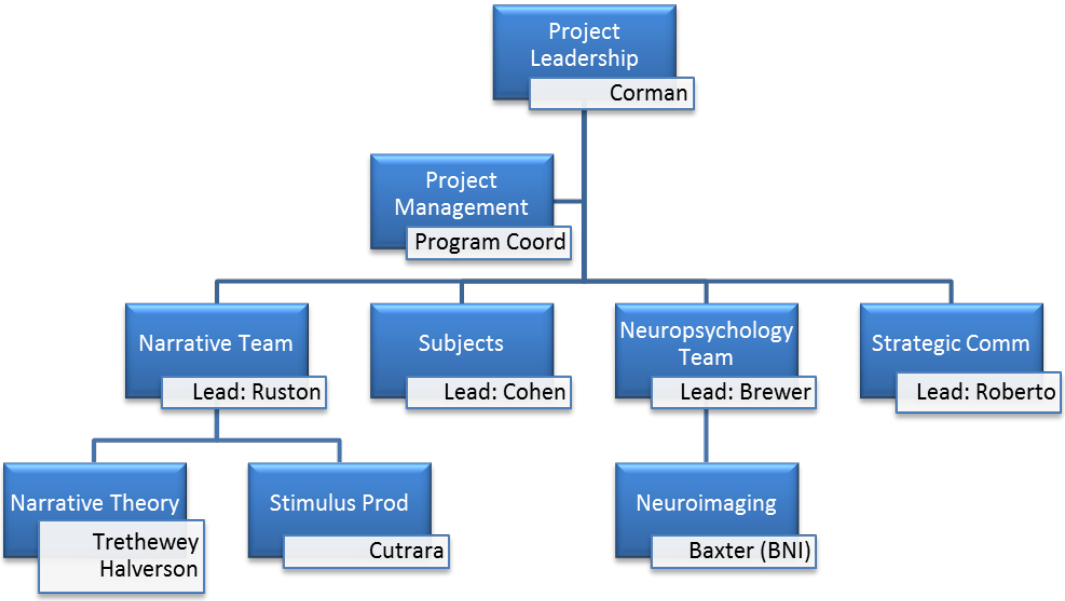
Each of these three separate areas has been studied extensively. Narrative is increasingly recognized as important in government strategic communication (Wallace, 2010; Mullen, 2009) and has been studied extensively from literary and humanistic traditions. Here, we draw from Fisher's (1989) narrative paradigm that helps to explain why people are often persuaded by seemingly irrational arguments by conceiving of humans as storytelling beings who are influenced by compelling stories. Halverson, Goodall and Corman's (2011) vertical integration model lends specificity and pragmatic analytic substance to Fisher's approach by articulating how narrative networks operate at transhistorical cultural levels, local levels, and personal levels, but there is currently little research that links narrative empirically to neural networks or persuasion, beyond narrative transportation (Green & Brock, 2004).

Correlating our Narrative Comprehension Network to persuasion relies on the elaboration likelihood model (ELM) of persuasion (Petty & Cacioppo, 1981) and extensions of that model (Slater & Rouner, 2002). This empirically supported model of persuasion suggests that there are two paths to persuasion – a central and peripheral route. When individuals are both motivated (and involved) and able (cognitively capable) to process a message, they employ the central route. Absent either condition, individuals rely on a peripheral route. Early empirical work suggests that narratives may inhibit central processing and reduce critical analyses of messages (Slater & Rouner, 2002, Moyer-Gusé, 2008). The neural basis for these effects has been examined, but to our knowledge relatively little research has used narrative theory as theoretical model for mapping a network of brain regions responsible for narrative persuasion.

Extant fMRI research in social neuroscience indicates that specific cognitive processes can be mapped onto specific brain regions (see Table 1, Section III.C.) and, importantly, that cognition emerges from a dynamic network of brain regions (Poldrack, 2008, 2010). Following Casebeer and Churchland (2003), we assume that discovering the basic neural principles in narrative processing, or what Fisher (1989) calls narrative rationality, "will require vastly more basic research in neuroscience, but correlating activity in certain brain regions with well-defined psychological conditions" (p. 169) will help guide research. We concur and believe that while social neuroscience is a maturing field, it has not adequately incorporated the study of narrative. Whereas there are psychologists who study narrative and transportation, insights from narrative theory could strongly enhance these approaches. Studies of culture and religion, too, have only recently begun to apply methods from neuroscience. Moreover, studies of culture and religion in psychology have not incorporated insights about narratives, even though cultures and religions provide master narratives, and people structure and give meaning to their lives in ways that derive from cultural and religious narratives.

Thus, this program of research takes these factors into account by defining the neural network that supports narrative comprehension and persuasion as defined in ecologically valid experimental conditions. Finally, cutting-edge multi-modal neuroimaging methods will provide a more nuanced strategy for mapping the neural networks of narrative comprehension and pesuasion (as measured by attitudinal and behavioral change), ensuring both spatial (fMRI) as well as temporal (EEG) resolution (Lei et al., 2011; Ritter & Villringer, 2006).

II.F. ORGANIZATIONAL CHART



Teaming Strategy. Lead roles of the investigators are shown in the chart above, but a team approach means personnel will support multiple functions as described in the following table:

							% Effort by Phase		
Personnel/Capabilties	Narrative Theory	Stimulus Production	Subjects	Neuropsychology	Neuroimaging	Strategic Comm	1	2	3
Baxter: Clinical neuropsychology, fMRI				●	●		10	10	10
Brewer: Neuropsychology, memory, EEG			●	●	●		25	25	25
Cohen: Psychology of religion, persuasion			●	●		●	16.7	16.7	16.7
Corman: Extremist narrative, strategic communication	●					●	25	25	25
Cutrara: Screenwriting, religion		●					8.4	2.8	0
Halverson: Religious studies, Islamism	●	●					5	5	5
Roberto: Persuasion, strategic communication			●			●	25	25	25
Ruston: Film and media studies, strategic communication	●	●				●	50	50	50
Trethewey: Ideology, strategic communication	●					●	16.7	16.7	16.7
Postdoc 1: Persuasion, strategic communication	●	●				●	100	100	100
Postdoc 2: Neuropsychology, neuroimaging			●	●	●		100	100	100

III.A. STATEMENT OF WORK

Scope

This project integrates narrative theory, psychology of religion, neuropsychology, neuroimaging, and transcranial magnetic stimulation to describe, explain, and test the response of a Narrative Comprehension Network to stimuli based in religious master narratives. The project builds on a core within-subjects experimental design in the first phase, adding between-subjects manipulations in Phase II to test hypotheses about the functions of the network identified in that phase. Phase III seeks to manipulate key accessible areas via Transcranial Magnetic Stimulation to provide strong inferences about the role those areas play in comprehension.

Location of Work

All work on this project, with the exception of the fMRI scans, will be performed on-campus at Arizona State University. The neuroimaging component will be performed in the Keller Center for Imaging Innovation at Barrow Neurological Institute (BNI) at St. Joseph's Hospital and Medical Center in Phoenix. Dr. Baxter will oversee all work done at BNI. This includes designing the neuroimaging task and acquiring all fMRI data. Dr. Baxter will obtain final institutional approval. All participants will be screened by Dr. Baxter's team at the Keller Center for MRI-compatibility. Quality control is part of all BNI studies; performed by a certified imaging engineer at BNI. Coded data are transferred by FTP to Dr. Baxter's office for analysis and storage, and ASU labs for further analysis.

Period of Performance

Phase I: April 1, 2012 – September 30, 2013 (anticipated start date)
Phase II: October 1, 2013 – March 31, 2015
Phase III (optional): April 1, 2015 – September 30, 2016

Detail

Phase I

TA& Subtask	WBS	Objective & Approach (Team)	Completion milestone(s)/ Deliverable(s)
1-all, 2-2,3,5	1.1.1	Hire staff. To include program manager, postdocs, and research assistants. (PIs)	Staff hired.
1-all	1.1.2	Design Experiments. Complete detailed design of scanning and persuasion experiments, to include specifications for selecting subjects, methods and instruments. (Subjects; Neuropsychology Team; Strategic Communication Team)	Design completed
1-all & 2-all	1.1.3	Human Subjects. Completion of human subjects applications and approvals for ASU and BNI. (PIs)	Approved protocols from ASU and BNI
1-all	1.2.1	Design Narrative Stimuli. Plan necessary parameters and requirements of the narrative stimuli to ensure congruence with the neuropsychological and persuasion test protocols. Conduct research to identify two mutually exclusive Master Narratives, one each drawn from Christian tradition and Muslim tradition. Identify local narratives (i.e.,	Master Narratives are selected, and local narratives are identified that can support the testing protocol.

		story systems in circulation) that share narrative components (story form, archetypes, etc.) with the Master Narratives. (Narrative Stimuli Team)	
1-1,3; 2-2,3,5	1.2.2	Pretest stimuli. Conduct preproduction formative research (interviews and/or focus groups) with target audience to test for: Awareness of master narratives, recognitions of the master narrative story form in the local narratives, distractions leading to lack of comprehension, satisfaction, transportation, and elements facilitating or impeding transportation. (Strategic Communication Team)	Written internal report with summary of results
1-2, 2-2,3,5	1.2.3	Video preproduction. The Narrative Stimuli team will complete all preproduction requirements for producing the stimuli materials, to include securing talent, locations, and existing footage. (Narrative Stimuli Team)	Screenplays for the 16 video vignettes; storyboards for vignettes; shooting plan.
1-2, 2-2,3,5	1.2.4	Video production. The Narrative Stimuli team will create the 16 stimulus videos. This will involve on-location shooting using digital video, recording of voice over, still photography, procurement, editing and digital manipulation of extant video material, and editing of videos on desktop non-linear editing (NLE) platforms. (Narrative Stimuli Team)	16 videos
1-1,3; 2-2,3,5	1.2.5	Pretest videos. Conduct postproduction formative research (interviews and/or focus groups) with target audience to make sure message is being interpreted as intended based on study goals and preproduction formative research findings. (Strategic Communication Team)	Written internal report with summary of quantitative results; slightly revised videos based on results
1-1,3; 2-2,3,5	1.3.1	Recruit subjects & pretest persuasion protocol with implications for extremist appropriation of religious master narratives. Have pool of potential participants complete screening survey, select and recruit eligible participants, pilot test persuasion protocol with a small sample and make minor modifications as needed before full implementation. (Strategic Communication Team)	Finalized persuasion protocol; begin and continue administer selection criteria until data collection is complete
1-1,3; 2-2,3,5	1.3.2	Run persuasion protocol. Run finalized persuasion protocol/experiment on all eligible participants that were recruited. (Strategic Communication Team)	Completion of all data collection for this portion of the study
1-1,3; 2-2,3,5	1.3.4	Analyze persuasion protocol. Run data analysis and write up results on data collected during persuasion experiments. (Strategic Communication Team)	One or more completed manuscripts to be submitted to conferences and for publication.
2-2,3,5	1.4.1	Recruit subjects & pretest scanning protocol. We will advertise the study to community participants at local mosques and churches. We will also validate the vertical integration in combination with EEG and fMRI techniques. (Neuropsychology Team)	Subjects recruited and techniques validated according to multimodal best practices.
2-2,3,5	1.4.2	Run scans. All participants will undergo scanning on the same 3Tesla scanner. EEG leads will be placed prior to the scan. The video-based task as well as a high resolution image will be obtained for analysis. (Neuropsychology Team)	Quantitative data collected.
2-2,3,5	1.4.3	Analyze fMRI and EEG data. Drs. Baxter and Brewer will conduct fMRI and EEG analysis with commonly used statistical imaging methods. (Neuropsychology Team)	Quantitative data analyzed.
1-all, 2-2,3,5	1.5.1	Knowledge capture & progress documentation. Document work group process at each meeting; Prepare monthly progress reports. (Team Leaders)	Progress documentation, monthly reports
1-all, 2-2.3.5	1.5.2	Report writing. Written reports documenting conceptual breakthroughs, methodological refinements, and findings for presentation at conferences and publication in major journals in representative disciplines. (Team	Report submitted; publications submitted

		Leaders)	
1-all, 2-2,3,5	1.6	Program management. (Lead; Program Manager)	Monthly reports
1-all, 2-2,3,5	1.7	Travel. Submit papers to conferences, schedule travel. Attend Kickoff meeting and PI annual meetings. (All)	Conference papers submitted and accepted; travel completed; monthly reports.

Phase II

TA & Subtask	WBS	Objective & Approach (Team)	Completion milestone(s) and/or Deliverable(s)
1-1,3; 2-2,3,5	2.1.1	Design validity and transportation manipulations. Conduct preproduction formative research (interviews and/or focus groups) with target audience to (1) generate ideas from them, and (2) check ideas we generate. (Strategic Communication Team)	Manipulations Designed.
1-1,3; 2-2,3,5	2.1.2	Pretest validity and transportation manipulations. Conduct postproduction formative research (interviews and/or focus groups) with target audience to make sure message is being interpreted as intended based on study goals and preproduction formative research findings. (Strategic Communication Team)	Quantitative data collected and analyzed
2-2,3,5	2.2.1	Recruit subjects & pretest scanning protocol. We will advertise the study to community participants at local mosques and churches. We will also validate the experimental manipulations in combination with EEG and fMRI techniques. (Neuropsychology Team)	Subjects recruited and techniques validated according to multimodal best practices.
2-2,3,5	2.2.2	Run scans. fMRI and EEG imaging will be done on the BNI 3 Tesla scanner as in Phase I. (Neuropsychology Team)	Quantitative data collected.
2-2,3,5	2.2.3	Analyze scans. Group analyses will be performed to determine the specificity of brain activity based on inclusion/exclusion in religious group. Comparison of validity and transportation. (Neuropsychology Team)	Data analyzed.
2-2,3,5	2.3.1	Recruit subjects & pretest persuasion protocol. We will advertise the study to community participants at local mosques and churches. We will also validate the persuasion measures using the vertical integration paradigm. (Strategic Communication Team)	Finalized persuasion protocol; begin and continue administer selection criteria until data collection is complete
2-2,3,5	2.3.2	Run persuasion protocol with implications for extremist appropriation of religious master narrativesWe conduct the persuasion measures simultaneous with the EEG/fMRI data collection using the vertical integration paradigm. (Strategic Communication Team)	Completion of all data collection for this portion of the study
2-2,3,5	2.3.3	Analyze results in accordance with the EEG/fMRI data analysis. (Strategic Communication Team)	One or more completed manuscripts to be submitted to conferences and for publication.
1-all, 2-2.3.5	2.4.1	Knowledge capture & progress documentation. Document work group process at each meeting; Prepare monthly progress reports. (Team Leaders)	Progress documentation, monthly reports
1-all, 2-2,3,5	2.4.2	Report writing. Written reports documenting conceptual breakthroughs, methodological refinements, and findings for presentation at conferences and publication in major journals in representative disciplines. (Team Leaders)	Report submitted; publications submitted
1-all, 2-2,3,5	2.5	Program management. (Lead; Program Manager)	Monthly reports

1-all, 2-2,3,5	2.6	Travel. Submit papers to conferences, schedule travel. Attend PI annual meeting. (All)	Conference papers submitted and accepted; travel completed; monthly reports.

Phase III

TA & Subtask	WBS	Objective & Approach (Team)	Completion milestone(s) and/or Deliverable(s)
2-2,3,5	3.1	Obtain TMS hardware, configure & train. (Neuropsychology Team)	Material acquisition ; TMS established.
2-2,3,5	3.2	Generate hypotheses to be tested by selectively interrupting particular brain regions. (Neuropsychology Team)	Narrative Disruption Hypotheses Articulated
2-2,3,5	3.3	Design experiments. Based on the narrative disruptors defined in 3.2, experiments will be designed to selectively manipulate the Narrative Comprehension Network with TMS. (Neuropsychology Team)	Experiments Designed
2-2,3,5	3.4	Run experiments. Use face reconstruction analysis of MRI scan to determine placement of the TMS stimuli. Determine if TMS use can alter response to video narratives. (Neuropsychology Team)	Experiments Conducted
2-2,3,5	3.5	Analyze results. Compare sham/TMS stimulation on group level to determine extent of alteration of the narrative response. (Neuropsychology Team)	Quantitative Data Analyzed
2-2,3,5	3.6.1	Knowledge capture & progress documentation. Document work group process at each meeting; Prepare monthly progress reports. (Team Leaders)	Progress documentation, monthly reports
2-2,3,5	3.6.2	Report writing. Written reports documenting conceptual breakthroughs, methodological refinements, and findings for presentation at conferences and publication in major journals in representative disciplines. Team Leaders)	Report submitted; publications submitted
2-2,3,5	3.7	Program management. (Lead; Program Manager)	Monthly reports
2-2,3,5	3.8	Travel. Submit papers to conferences, schedule travel. Attend PI annual meeting. (All)	Conference papers submitted and accepted; travel completed; monthly reports.

III.B. RESULTS, PRODUCTS AND TECHNOLOGY TRANSFER

This project will result in significant advances in neuroscience, cognitive, social, and cultural psychology, narrative theory, and build the scientific foundation for dramatic shifts in strategic communication capability. Our multidisciplinary research will produce new knowledge about neural networks, how narrative works (especially in the context of political violence and religious narratives), as well as establishing important experimental paradigms for subsequent scientists to further this research.

Results and Products

Knowledge

This project will provide empirical evidence integrating brain regions and cognitive processes into a neural network of narrative comprehension. By virtue of the experimental design, these relationships will also directly inform the primary aspects of narrative and strategic communication under examination: narrative validity, narrative transportation, and vertical integration. The empirical correlation of narrative theory to neurocognitive activity is an important advance in the understanding of narrative and how the brain governs narrative comprehension.

This project will advance current neuroscience research by examining the effects of culture and religion on narrative comprehension within the brain. Furthermore, the multi-modal approach to studying narrative comprehension is a major advancement in the cognitive neuroscience of narrative comprehension due to the use of simultaneous brain measurement with neuroimaging techniques that have both high spatial (fMRI) and temporal (EEG) resolutions that allow more precise knowledge of the flow of activity during narrative processing. The combination of these neuroimaging techniques provides important information about the brain regions that support narrative comprehension as well has how comprehension emerges through the interaction of these regions.

To further advance our understanding of narrative into the domain of subject proclivity to engage in or support political violence, our research program will correlate narrative effects to attitude, intention and behavioral effects, thus cross-referencing the narrative theory and neural activity to persuasiveness.

Finally, this project will create a fundamental basis for understanding how to disrupt or enhance aspects of narrative structure, and/or brain functioning, to minimize or maximize persuasive effects on subject proclivity to engage in political violence.

Parameters for Future Models

Mapping the Narrative Comprehension Network will provide empirical leverage for developing models of narrative comprehension that are biologically plausible. Moreover, the current research will establish how narrative elicits persuasion in the brain. Therefore, modelers will have important input about both the biological network responsible for narrative comprehension and behavioral outcomes from manipulating the network. These data will provide strong data for parameterizing bring modeling endeavors.

Experimental Paradigm

The creation and validation of an experimental paradigm for investigating narrative comprehension will be a major advancement in the experimental study of narrative persuasion. Little experimental advancement has occurred in the study of narrative, especially with regard to vertical integration. The current research will develop an experimental paradigm that can be used to study narrative validity, transportation, vertical integration, and persuasion. Furthermore, this experimental paradigm will be developed for both laboratory investigations and neuroimaging investigations. Therefore, this paradigm will be useful for a wide variety of researchers in narrative theory, experimental psychology, social psychology, and cognitive neuroscience.

With regard to the experimental paradigm, we will identify master narratives that differ between religious groups, develop video vignettes that map onto these master narratives, collect normative data regarding these videos, and create a multi-modal (fMRI+EEG) experimental design for investigating the Narrative Comprehension Network.

Technology Transfer Path

As mentioned previously, this project provides the underlying science to understand narrative processing in the brain. This offers a scientific basis upon which to craft strategic communication methods that can influence discourse systems in which narratives circulate. This influence can be in the form of an "inductor" or "disruptor."

The inductor application describes a change introduced by a strategic communication effort that, in accordance with our research, will induce a higher amount of narrative validity, transportation, and vertical integration within a target audience. The Narrative Comprehension Network model provides the basis for pre-testing such materials to ensure they activate the appropriate neural network components to maximize narrative induction. Results from the persuasion portion of our paradigm will associate such changes with attitudes and behaviors. Thus, results of this study will allow strong predictions of whether a particular narrative message will influence audiences in a desired direction, and what the attitudinal/behavioral outcomes of those influence attempts are likely to be.

The disruptor application describes a change introduced by a strategic communication effort that will selectively lower the amount of validity, transportation or vertical integration associated with a narrative within a target audience. **The practical application here is a case where extremists are influencing members of a community to support or tolerate them, for example by invoking a religious master narrative as an analogy for current local events. Understanding how people process such messages it will support design of strategic communication interventions to reduce the narrative's effect.** For instance, it will be possible to understand how introducing new stories into the narrative system could disrupt its coherence, clouding the analogy between the master narrative and local narrative.

On the whole our research effort promises to provide a scientific basis upon which to craft strategic communication materials in government and military strategic communication, both to enhance desired messages and degrade those of opponents. This is a revolutionary capability for the enterprises of public diplomacy, military information support operations, and public/civil affairs, which to date operate more on the basis of art than science.

III.C. DETAILED TECHNICAL APPROACH

As Khaled jumped off the truck, fanning out with his comrades, he heard the Mirage fighter jets scream overhead. Just as he had planned, no one at the parade suspected what was about to happen. The spectators thought the squad was just another part of the show, but soon they would learn otherwise. He shouldered his AK-47 just as the grenades exploded. Taking aim and squeezing the trigger, he sprayed the reviewing stand with bullets. As the butt of the rifle jack-hammered him, Khaled wondered if he had made a mistake by organizing the attack. But then he remembered what God had said to the Pharaoh in ancient times: "This day shall We save thee in the body, that thou mayest be a sign to those who come after thee! But verily, many among mankind are heedless of Our Signs!" All his doubts evaporated. Martial law was the last straw, just as the Shaykh had said. It proved beyond any question that the President was the leader of the heedless, and now he was experiencing God's justice. As the generals and officials on the stand scattered like roaches Khaled saw his target slumped in the chair, bloodied and apparently lifeless. He had done it! As security personnel finally began closing in, he raised the rifle triumphantly above his head and screamed, "I have killed the Pharaoh!"

This is the true story of the assassination of President Anwar Sadat of Egypt during a military parade on October 6, 1981. It illustrates the profound power of *narrative*—a system of stories sharing themes, forms and archetypes—to catalyze political violence. Narrative operates on three levels of *vertical integration* (Corman, 2011) in this story. At the highest level is a *master narrative*, a system of stories that is transhistorical and widely understood by members of a culture (Halverson, Goodall, and Corman, 2011). It is invoked in the quote from the Qur'an (10: 91-92), part of a narrative[1] about the confrontation between Moses (*Musa*) and the Pharaoh of Egypt. It casts the Pharaoh (*Firaun*) as a corrupt tyrant who deserves, and receives, Divine retribution.

Such narratives can be integrated at an intermediate level as analogies to frame *local narratives*, comprising stories about things happening in the here and now. The extremist organization *al-Gamaa al-Islammiyya* had done just that, telling stories that cast Sadat as a modern day Pharaoh in response to his crackdown on Islamists and declaration of martial law. Omar Abdul Rahman, the "Blind Shaykh," issued a *fatwa* permitting the assassination of Sadat, using the Qur'anic narrative as a basis, thus connecting the local story system to the pre-existing religio-historical story system. At the lowest level of integration Lt. Khaled al-Islambouli, who was associated with the radical group, aligned his *personal narrative* with the local one. He assumed the role of God's agent by organizing the plot to assassinate Sadat. He repeated his "I have killed the Pharaoh" declaration at his trial.

The story is effective because of this vertical integration, but also because it is *valid* from a narrative point of view (having both *coherence* and *fidelity*; Fisher, 1985) and achieves *transportation* (Green & Brock, 2000) for most readers. Extremists of all stripes routinely draw upon a *rhetorical vision* (Bormann, 1972) composed of master narratives in their strategic communication, using them to frame local narratives and encourage individuals to align their personal narratives accordingly (Corman, 2011). Yet despite strong anecdotal evidence of the effectiveness of this strategy, including the dramatic example of the Sadat assassination, there is little understanding of how narratives work on a neurological level to persuade. This is a crucial

[1] The narrative is made up of a number of stories including Moses confronting the Pharaoh on God's command and being rejected, Moses's contest with the Pharaoh's magicians, the plagues sent by God against the people of Egypt, and the Exodus and subsequent drowning/preservation of the Pharaoh.

gap: Although narratives circulate culturally, they have their ultimate practical effect in the actions of individuals. This project addresses technical areas I and II to substantially increase our understanding of these processes. Our objective is to map the Narrative Comprehension Network (NCN) of the brain, understand its structural alignment with the theoretical concepts above, and explain how its activity relates to persuasive outcomes in attitudes and behaviors. Ultimately, our project offers the capability to induce or disrupt the operation of narratives within the brain, and develops the capability to induce narrative validity, transportation and integration with certainty.

Need for This Research

This project integrates insights from three mutually-informing theoretical terrains: (1) narrative networks in circulation in contemporary cultures, particularly those narratives that are appropriated by extremists to promote, support, and justify violence; (2) brain networks, the neural and cognitive pathways through which the brain processes narrative as measured by multi-modal brain imaging techniques; and, (3) meaning networks or the patterns of interpretation and influence—attitudinal, intentional and behavioral changes—that accrue when narrative neural networks are activated. We will focus on religious narratives partly because of the theoretical opportunities they provide and partly because of their power in catalyzing extremist behavior.[2]

Each of these areas has been studied extensively but separately: Currently, there are no research programs that bring these networks together in one comprehensive model. This project will accomplish that integration by mapping a Narrative Comprehension Network. Our project promises to provide empirically tested resources for effective strategic communication interventions. Our network model will enable end users to identify, for example, the neural networks that are activated by particular *local narratives* and the resultant behavioral changes that neural/narrative combination inspires. Additionally, once we have produced a narrative comprehension model, end users will understand how to activate known neural networks (e.g., working memory or attention) and positive behavioral outcome (e.g., nonviolent actions) nodes with strategic communication messages as a means to reduce the incidences of political violence in contested populations.

Narrative is increasingly recognized as important in government strategic communication. Former Secretary of Defense Robert Gates has expressed concerns about the negative narrative surrounding the war in Afghanistan (Wallace, 2010). The Chairman of the Joint Chiefs of Staff has talked about the need to "supplant the extremist narrative" (Mullen, 2009, p. 4). In recent congressional testimony, Daniel Benjamin (The State Department's Counterterrorism Office, 2011) described delegitimizing extremist narratives as one of the top priorities of the Office of Coordinator for Counterterrorism.

It is also clear that stories and narratives are regular features of extremist strategic communication. The CSC maintains a large, searchable database of extremist discourse as part of an ONR funded grant (N00014-09-1-0872) studying Islamist extremist narratives. This database contains approximately 2800 texts: Forty-five percent of these invoke at least one of the master narratives of Islamist extremism, and 28% invoke more than one master narrative. Over one-third have been reliably coded as containing one or more stories.

[2] While there is considerable debate about whether religion actually causes extremist behavior, it is certainly true that extremists appropriate religious narratives to justify their actions, and to recruit people to their causes.

Table 3.1 Summary of existing research on cognition and brain regions, as they potentially relate to narrative theory.[3]

Theory/Concept	Component	Cognitive	Brain Regions	Brain Network	Relevent Research
Vertical Integration					
Master Narrative	Cultural Script	Semantic Memory		Memory Network	
	Schema	Semantic Memory	LIFG	Memory Network	Thompson-Schill (2003)
Local Narrative	Recognizing Archetypes	Recognition Memory	Hipp, PC, PFC	Memory Network	Rugg & Yonelinas (2003)
	Mapping Archetypes	Analogical Reasoning	PFC	Working Memory Network	Goel & Dolan (2004)
Personal Narrative	Self Reference	Self Reflection	PFC	Working Memory Network	Lieberman (2007)
	Identification	Autobiographical Memory	Hipp	Working Memory Network	Lieberman (2007)
Narrative Paradigm					
Coherence	Component Integration	Attention	TPJ, STL, SPL, FEF, SC	Attention Network	Posner & Fan (2004)
	Departure from regularity	Error Processing	ACC	Limbic System	Bush et al (2000)
	Coherence Assesment	Reasoning	PFC	Working Memory Network	Christoff et al (2003)
Fidelity	Cultural Value Alignment	Social Values	aTL, PFC, VTA, Hypo, Sep	Fronto-Mesolimbic Network	Zahn et al (2009)
	Social Consistency	Social Judgment	PFC, MPAC	Working Memory Network	Lieberman (2007)
	Idelalsim Assesment	Emotion	Amy	Limbic System	LeDoux (2000)
Narrative Transportation					
Imagery	Visual Imagery	Imagery	PVC & SVC	Visual Network	Kosslyn et al (1999)
	Perspective Taking	Theory of Mind	PFC & PCC	Mentalizing Network	Buckner & Carroll (2006)
	Intention	Working Memory	PFC & Hipp	Working Memory Network	Simons & Speers (2003)
Affect	Positive Mood	Reward Induces Affect	VTA, Amy, Hipp, ACC, PFC, Nac, SN, LC	Working Memory Network	Ashby et al (1999)
	Emotion Regulation	Executive Functions	PFC	Working Memory Network	Rolls (2004)
	Attitude	Explicit Attiude Expression	PFC, MPAC, & LPAC	Frontoparietal Network	Lieberman (2007)

Despite the recognized importance of narrative, little is known about how it functions on the individual level in terms of neurology or persuasion (attitude change and behavior). For one thing, much of what is known about narrative is strictly theoretical. This theory comes primarily from the humanities, which values scholarly individualism and tends not to prioritize generalizable empirical research. Of the theoretical perspectives cited at the beginning of this section, only narrative transportation theory has received any significant empirical testing.

[3] Footnote for 3.1 The brain areas and networks reflected in this table represent hypothesized regions derived from published research cited therein. While these are areas of interest we fully anticipate additional important areas to become apparent.

Table 3.2 Key for brain regions in Table 3.1 and Figures 3.1-2.

ACC	Anterior Cingulate Cortex	PCC	Paracingulate Cortex
Amy	Amygdala	PFC	Prefrontal Cortex
aTL	Anterior Temporal Lobe	PVC	Primary Visual Cortex
FEF	Frontal Eye Fields	SC	Superior Colliculus
Hipp	Hippocampus	Sep	Septum
Hypo	Hypothalamus	SN	Substantia Nigra
LC	Locus Ceruleus	SPL	Superior Parietal Lobe
LIFG	Lateral Inferior Frontal Gyrus	STL	Superior Temporal Lobe
LPAC	Lateral Parietal Cortex	SVC	Secondary Visual Cortex
MPAC	Medial Parietal Cortex	TPJ	Temproal Parietal
Nac	Nucleus Accumbens	VTA	Ventral Tegmentum Area
PC	Perirhinal Cortex		

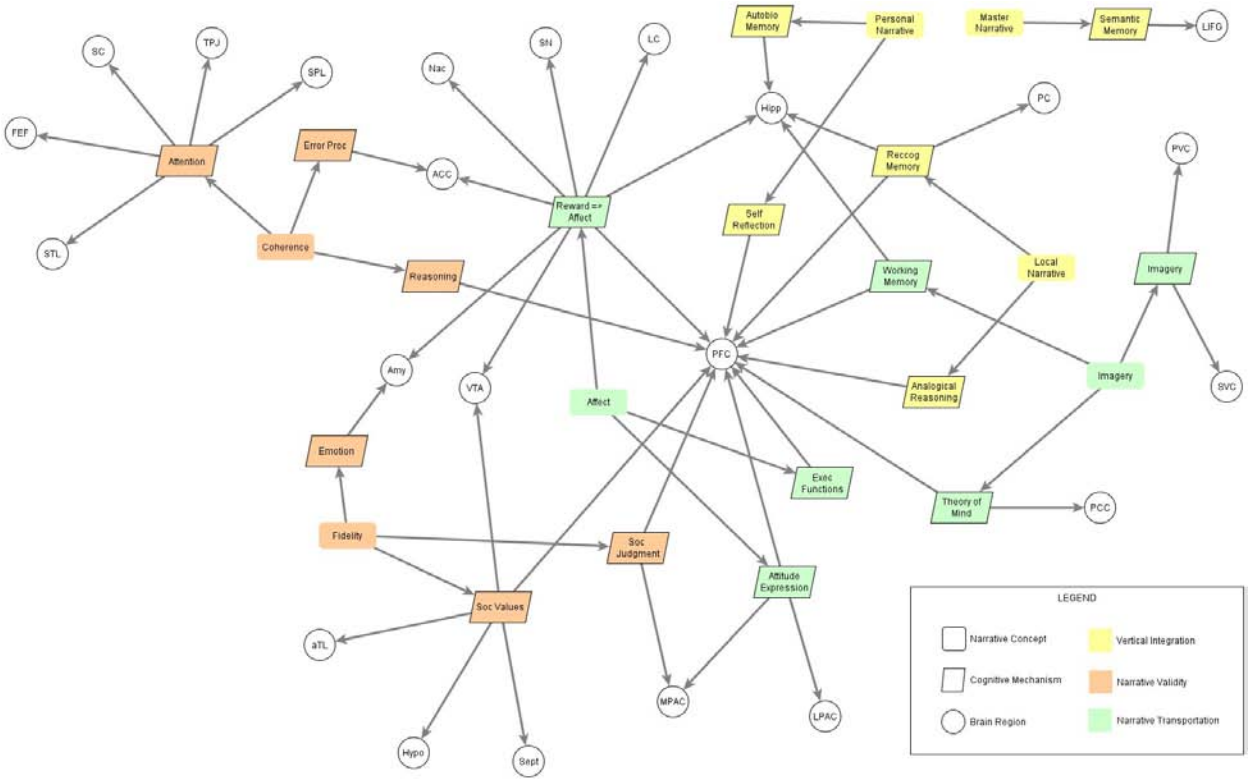
Much fMRI research has focused on mapping cognitive processes onto specific brain regions. Table 3.1 shows the main narrative concepts introduced above, the cognitive processes they imply, and existing research on associations between those processes and brain regions. More recent work, however, suggests that networks of brain regions underlie higher-order cognition (Poldrack, 2008, 2010), and contemporary neuroimaging research acknowledges that cognition emerges from a dynamic network of interconnected brain areas. Evidence for the utility of a network view comes from studies of human memory (Simons & Spiers, 2003), language (Xu et al., 2005), and attention (Posner & Peterson, 1990).

This project adopts the network approach to define the neural network that supports narrative comprehension and persuasion. That is, we plan to use neuroimaging techniques to help define the brain regions that support narrative comprehension and specify how they support narrative comprehension across time. Figure 3.1 shows information from Table 3.1 as a three-mode network incorporating narrative theory concepts, cognitive mechanisms they imply, and brain regions associated with the mechanisms. The possible configuration of the NCN is derived in Figure 3.2 by extraction the regions-mode from this network; two brain regions are connected if they are both associated with a common cognitive process. Please note that neither figure is intended to represent spatial proximity of the brain regions. While this provides an example of a possible configuration that might emerge from this project, it cannot be taken as a strong hypothesis because inference from brain imaging studies can be problematic (Poldrack, 2008, 2010).

To rigorously describe the NCN we will use a multi-modal neuroimaging approach. fMRI typically has excellent spatial resolution properties so researchers can make inferences about very specific brain regions that support cognition. However, a tradeoff exists between spatial and temporal resolution such that inference about how brain regions are operating over time is difficult using fMRI. Another neuroimaging technique, electroencephalography (EEG), has excellent temporal resolution (i.e., can take >500 measurements per second). EEG trades spatial for temporal resolution, the opposite of fMRI. Together these two neuroimaging techniques provides researchers with excellent spatial (fMRI) and temporal (EEG) resolution (Ritter & Villringer, 2006). The combination represents a cutting edge approach to identifying neural networks, and we will adopt such a combination in the current work to generate new theoretical understandings of the neural networks that serve narrative comprehension.

The use of fMRI in persuasion research is still in its infancy, as suggested by the following recent statement by leading researchers in the field: “This is the first functional magnetic resonance imaging study to demonstrate that a neural signal can predict complex real world behavior days in advance” (Falk, Berkman, Mann, Harrison, & Lieberman, 2010, p. 11934). In this study, Falk et al. found that activity in the medial prefrontal cortex predicted an average or 23% of the variance in behavior change beyond the variance predicted by self-reported attitudes and intentions. Thus, they conclude, “neural signals can

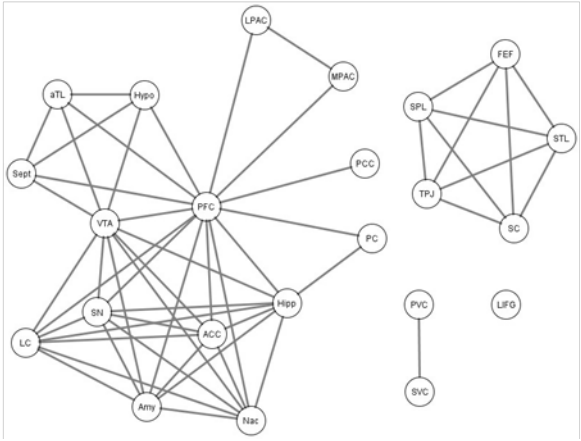
Figure 3.1 Three-mode network relating narrative concepts, cognitive mechanisms and brain regions from Table 3.1. It does not represent spatial proximity of regions, but rather those that have been connected to particular cognitive mechanisms in existing research.



predict behavioral changes that are not predicted from self-reported attitudes and intentions alone" (p. 11934).

An earlier study by Falk and colleagues (Falk, Rameson, Berkman, Liao, Kang, Inagakil, & Leiberman, 2009) did not deal directly with behavior, but instead dealt with "the moment the persuasion process occurs" (p. 2447). These authors found that "across three studies, including two different cultural groups [i.e., American and Korean] and two types of media [i.e., print and video], persuasion was associated with a consistent network of regions in the brain" (p. 2447), including increased activity in posterior superior temporal sulcus bilaterally, temporal pole bilaterally, and dorsomedial prefrontal cortex. Together, these studies suggest that much can be learned by using fMRI to study persuasive effects, and the proposed project aims to make significant contributions to this new but important body of literature. Therefore, there is potential for significant theoretical advancement in this area. Integrating narrative theory in an empirical context will provide new understandings of how vertical integration, narrative validity, and narrative transportation relate to one another. The next section details our approach for achieving these outcomes.

Figure 3.2 One-mode network of brain regions showing a possible configuration of the NCN. Two regions are connected if the have a cognitive mechanism in common. Does not represent spatial proximity of regions.



Research Objectives and Design

Phases

This project is proposed in three phases. The objective of *Phase I* is to map the Narrative Comprehension Network using a set of stimuli (described below) designed from the point of view of two different religious cultures. This will permit manipulation of the master narrative →local narrative and local narrative → personal narrative correspondence in a way that will expose important differences in how the brain processes narrative as a joint function of an individual's cultural affiliation coupled with the strategic information contained in the narrative. This descriptive step will afford generation of hypotheses about how elements of the NCN respond to variations in narrative, to be tested in the next phase.

Phase II will test hypotheses generated in Phase I, adding two additional manipulations of narrative validity and narrative transportation. A hypothesis-driven effort is necessary because of the significant danger of confirmation bias in fMRI research (Aue, Lavelle, and Cacioppo, 2009). Validity and transportation are necessary conditions for narrative effects, and adding conditions for these will afford conclusions about possible narrative technologies (interventions) that could interfere with the persuasive effects of NCN activation.

Phase III investigates possibilities for literally disrupting the activity of the NCN through Transcranial Magnetic Stimulation. It will allow testing of the centrality of various regions in the NCN, those with the most critical influences on specific persuasive effects. This phase is important for identifying the proper relationship between regions in future NCN models, and for providing a strong test of necessity of particular regions for narrative processing.

Next we detail the narrative concepts introduced at the beginning of this section, which drive our experimental design and phase structure. Then we explain how we will construct stimuli for multi-mode (fMRI/EEG) analysis of the NCN, how we will select subjects, and how the experiments will be designed. Finally we describe the theoretical and practical benefits of the project.

Narrative Theory

We are story-telling beings—what Walter Fisher (1989) calls *homo narrans*. As such we see the world through a narrative logic rather than a rational logic. Whereas rational logic aspires to be objective, repeatable, consistent and impersonal, narrative logic works on completely different principles. It is rooted in the simultaneously cognitive and emotional processing of information that marks human behavior, and finds its validity in principles of coherence and fidelity. These qualities help explain the seemingly irrational persuasive power of narrative, and, importantly, provide guidance for how to manipulate narrative stimuli in order to accurately map the Narrative Comprehension Network in the brain. Mapping this network will lead to a fuller understanding of the influence narrative has on memory, emotion, theory of mind, identity and persuasion, which in turn influence the decision to engage in political violence or join violent groups or support such groups ideologically or financially.

Our project will focus on three theoretical constructs to examine narrative and persuasion, especially the persuasion related to political violence: Vertical integration, narrative validity, and narrative transportation. These theories, drawn from strategic communication, human communication and psychology, offer a comprehensive and interlocking framework to investigate the phenomenon of narrative that is also congruent with prevailing narrative theories from the literature and film studies (the traditional province of narrative studies.)

Vertical Integration

Vertical integration is a theory of narrative in which widely held narratives that are prevalent throughout a culture (called *master narratives*; Halverson, Goodall, and Corman, 2011) provide templates for individuals within that culture to comprehend contemporary events and situations through local and personal narratives. Individuals need not interpret local events in terms of these master narratives, but master narratives provide a plausible framework for comprehension. Cognitive narrative theory holds that narrative comprehension is the dual level process with both top-down and bottom-up components (Branigan, 1992). Culture provides schema, or templates, for ordering narrative data (top-down); individuals process incoming story data and organize it with a selected schema. The process continues until comprehension is achieved, or lack of comprehension mandates implementation of a new schema. A master narrative can be seen as an exemplar narrative schema. Because master narratives embody specific cultural values, they can be strategically deployed as an explanatory frame for current events in order to encourage a particular interpretation and for persuasive purposes. Master narratives execute ideological functions, positioning these cultural values as naturalized and universal (Trethewey, Corman & Goodall, 2009).

As psychologist Donald Polkinghorne notes, "People conceive of themselves in terms of stories. One's future is projected as a continuation of the story, as yet unfinished"(Polkinghorne, 1988, p.107). Vertical integration is achieved when personal, local and master narratives all line up consistently. This congruence formulates a powerful model for identity formation and persuasion. In the case of Khalid Islambouli, his actions and statements illustrate that he interpreted the contemporary events of modern Egypt in terms of the master narrative of the tyrannical Pharoah from the Qu'ran. His actions demonstrate Polkinhorne's claim that one's future is a *continuation* of a story—here Islambouli continues the tyranny story by interjecting himself as God's agent into the story and writing the end to Anwar Sadat's rule and reframing his own character as a *shahid* for the Islamist cause.

Cognitive processes that are indicated by vertical integration to be part of the Narrative Comprehension Network include: self-recognition, identity, and theory of mind (to see oneself in a story), pattern recognition (to see parallels between master narratives and contemporary situations), and memory (to remember the master narrative elements). The first phase of our experimental design provides for a thorough, within-subjects exploration and validation of the sub-components of vertical integration. Subjects will experience narrative stimuli both congruent and incongruent with religious master narratives they recognize. They will also be asked to project or not project themselves into the story, allowing for the visualization of the different brain regions activated in each case.

Narrative Validity

Walter Fisher's narrative paradigm (Fisher, 1985, 1989) posits that human beings make decisions not based on a rational world paradigm, where benefits and detriments are objectively and dispassionately assessed prior to decision-making, but rather on a narrative paradigm. In the narrative paradigm, data are understood in terms of a story and the story is valued in terms of its coherence (internal story logic) and fidelity (congruence with already-deemed-true stories). The combination of these two principles of coherence and fidelity is known as *narrative validity*.

The frequent rejection of US messaging by local populations in the Middle East, despite US insistence on the objective truth of the US message, illustrates the narrative paradigm at work. The well documented "say-do gap" between US messages and US actions is seen by some

as contributing to a lack of narrative validity in stories produced by the US. Similarly, stories of US aid do not ring true in a culture wherein Christian foreigners, since the 11th Century, have been invaders and sought to destroy and rule.

Fisher's narrative paradigm specifically addresses decision-making in three important ways: (1) narratives enable people to make judgments about good and evil, (2) narratives tell us what stories we should adopt, and (3) narrative rationality predicts whether or not we should accept a story, whether or not it is a "trustworthy" guide to belief and action. Investigating narrative validity offers two benefits: First, we will understand what areas of the brain are involved in the assessment of narrative validity, which has second order effects on decision-making and value judgments; second, we will be able to detect when a piece of communication exhibits narrative validity—a valuable force multiplier for public diplomacy and information operations.

Narrative Transportation

Narrative Transportation Theory describes the phenomenon of an individual being absorbed into a story or narrative system such that awareness of the individual's surroundings is diminished or eliminated (see Gerrig, 1993). Additionally, "a transported reader suspends normal assumptions and treats the narrative as the frame of reference" (Green, 2004, p. 248). This measurement of the power to captivate an individual's mind has been shown to influence, or perhaps encompass, the persuasive power of a narrative.

Understanding narrative transportation is a crucial element of investigating the persuasive power of narrative and its relationship to joining political violence. Existing studies of the phenomenon have indicated that transportation may reduce basic cognitive and elaborative activities that underlie resistance to persuasion (Appel & Richter, 2010). Thus, the release of attention to the physical or "real" world also induces a release of cognitive faculties related to critical review and assessment. In addition, transportation involves strong emotional experiences that can facilitate narrative persuasion via positive mood.

The component of narrative transportation which supplants "normal assumptions" with the narrative as the primary reference echoes Fisher's narrative paradigm and the primacy of a narrative rationality when narrative validity is achieved. Our research program will determine if successful narrative transportation is required for maximum persuasive effect, as the theory suggests. In addition, the correlation between narrative validity, vertical integration and narrative transportation will be made evident. Finally, our research will identify those parts of the brain activated during narrative transportation, which will lead to ways to stimulate the transportive effects of messages.

E/ELM

Two related perspectives in persuasion research are relevant to the role of narrative in influencing audiences. According to the elaboration likelihood model (ELM; Petty & Cacioppo, 1981), there are two "routes" to persuasion. Individuals who have both the motivation (e.g., personal involvement or relevance) and the ability (e.g., cognitive capability) to process a persuasive message will do so via the central route. These individuals will carefully examine and critically evaluate the information and arguments presented in the message, and will be persuaded by arguments that they perceive to be strong. Individuals who lack either the motivation and/or the ability to process a message will process it via the peripheral route. In this instance, little effort or thought is put into evaluating the message arguments and instead

individuals base their decision on simple decision rules, or heuristics, that are not directly related to the substance or quality of the message.

A recent extension of the model (the E-ELM) by Slater and Rouner (2002) argues that individuals watching narrative messages will be less critical and produce fewer counterarguments (i.e., that they are more likely to process the message peripherally). For example, individuals watching narratives may not realize the message is trying to persuade them, and therefore do not react in ways they otherwise might to a more traditional and obvious persuasive message. This perspectives has clear connections to findings from narrative transportation research. But while the ELM has been studied extensively in a variety of contexts, its extension to narratives where the persuasive intent might be not as obvious or completely hidden is still in the early stages (Slater & Rouner, 2002, Moyer-Gusé, 2008).

Stimuli

A critical component of this research project is the narrative stimuli presented to the subjects in order to complete the research design and observe brain function during the perception and comprehension of narrative material. The research design calls for testing different successful and unsuccessful permutations of vertical integration, as well as narrative validity. For the initial phase of testing, the research design calls for 16 stimuli so that each of the 20 subjects will be exposed to material in the following categories:

- Master Narrative providing resources to Local Narrative which offers opportunity for Personal Narrative (MN→LN→PN);
- Master Narrative related to Local Narrative but no connection for Personal Narrative (MN→LN ⊗ PN);
- Master Narrative and Local Narrative not related, but Personal Narrative opportunity present (MN ⊗ LN→PN);
- Master Narrative unrelated to Local Narrative and no connection for Personal Narrative (MN ⊗ LN ⊗ PN). In the second phase of the project, 160 subjects will be exposed to the same narratives, and divided by narrative validity.

A significant challenge exists in the creation of contemporary stories that, on the one hand, can be told in terms of a master narrative, and, on the other hand, offer an opportunity for an explicit continuation of the subject's own personal narrative (Polkinghorne, 1988). Contemporary media abounds with stories that embody master narrative elements. For example, the 1977 film *Star Wars* is a contemporary story (both contemporary to 20th century American popular culture in the science fiction genre or, diegetically, contemporary to a far galaxy) that embodies the story form of the Hero's Quest and the archetypal characters of the Wise Sage, the Dark Knight, and the Virgin/Princess. It can be read in terms of the David and Goliath master narrative, whereby a young and inexperienced warrior defeats a seemingly invincible foe by virtue of faith. Another example of a contemporary (or local narrative) presented in terms of a master narrative would be the Oliver Stone film *Platoon*. A coming-of-age film, *Platoon* positions an archetypal struggle for competing models of masculinity and virtue in the jungles of Southeast Asia.

As these two examples illustrate, a specific master narrative need not be referenced by name in the local narrative for the master narrative to provide a plausible and culturally familiar schema for interpreting the local narrative elements. The project team will engage two successful screenwriters as consultants to ensure the highest quality of concept and story design. These consultants will each have expertise in our subject religions (Christianity and Islam), and

will have experience creating compelling contemporary stories that invoke deep-rooted cultural narratives. By utilizing a combination of specifically produced video vignettes and existing footage excerpted from popular media and news sources, we will create an array of compelling local narratives to present to the subjects.

As an example of how contemporary events are rendered in congruence and incongruence with a master narrative, we offer the following example. In the master narrative of the Exodus, an archetypal prophet, Moses, emerges from within the ancient Israelite community that is oppressed and enslaved in order to liberate the people from bondage. For many African-Americans, the Exodus was analogous to the civil rights movement led by MLK Jr. in the 1960s. It could serve as a basis for the variation in stimuli described above as follows:

- MN→LN→PN. Vignette shows MLK leading marches of the civil rights movement with speech segments referencing "seeing the Promised Land." PN: subject can continue legacy by emulation of his righteous example and support/practice nonviolent civil rights activism.
- MN ⊗ LN→PN. Vignette shows MLK as a leader mocked by Malcolm X, who invokes religion to justify his positions. PN: subject can support the black nationalist ideals of Malcolm X as a superior strategy and position.
- MN ⊗ LN ⊗ PN. Vignette depicts a case of racist discrimination against African-Americans in contemporary Alabama. PN: subject can express anger and frustration at the problem of racism in Alabama (or America), perhaps rooted in personal experience.

These vignettes are only a sample of a possible arrangement of local narrative context in terms of master narrative and options for personal narrative to intertwine with the local narrative (important to access the persuasive outcomes of narrative).

To support the research design, a comprehensive set of local narrative videos will be created, one-half referencing a Christian master narrative, one half referencing a mutually exclusive Muslim master narrative, following a similar pattern. In the initial phase, all 20 subjects will view all the vignettes, thus those vignettes drawing on a foreign and unknown master narrative should not activate vertical integration, nor narrative validity.

Subjects

In this program of research we are focusing on members of two religious communities, Christians and Muslims (Dr. Cohen has demonstrated via grant supported work the ability to successfully recruit US Christians and Muslims). The choice of Christian and Muslim participants affords us a number of theoretical and practical opportunities. They share a number of key similarities for the purpose of our research, including several similar master narratives (e.g. they share cosmology, are monotheistic, and both are Abrahamic religions). They also have several importantly different master narratives (e.g. the primacy of Mohammed's prophecy for Muslims, the divinity of Jesus for Christians). We can leverage these similarities and differences to design our stimuli.

There are several advantages to choosing religious narratives. First, religion is ubiquitous; every culture has some form of religion, and most people in the world are religious. Even if they are not, religious narratives pervade cultures in ways that religious master narratives are familiar to people even if they are not personally religious (Cohen, 2009; Saroglou & Cohen, in press). Third, they are particularly evocative. Religious narratives are among a small set of kinds of narratives that can guide people's ultimate concerns (Emmons, 2003), making people willing to devote their lives to the charitable service of others, to kill or die in the service of

religion.

To have additional opportunities to test what features of people (in addition to their religious affiliations) affect neural responses to narratives, as well as to control any confounds in group comparisons, we will also measure several individual difference variables related to religious outlooks: intrinsic religiosity, extrinsic religiosity, quest, and fundamentalism.

The most conceptually influential approach to studying religiousness in psychology comes from Allport's distinction between intrinsic and extrinsic religiosity (Allport & Ross, 1967). Intrinsic religiosity is seen as internalized, mature religious motivations. Extrinsic religiosity is an instrumental use of religion; these instrumental uses are often characterized as social or personal (being a member of a religious community; personal comfort or relief from stress). Other important religiousness theories and scales focus on fundamentalism and quest. Fundamentalism means deriving meaning from an immutable and inerrant sacred text (Hood, Hill, & Williamson, 2005). Quest consists of viewing religion as a search for answers rather than as a fixed, immutable set of truths (Batson, Shoenrade, & Ventis, 1993).

The scales we will use will be the Revised Religious Orientation scale which contains three subscales: Intrinsic religiosity (14 items, α=.83), extrinsic religiosity – social (extrinsic religiosity based on motivations related to social and community integration, 3 items, α=.87), and extrinsic – personal (extrinsic religiosity based on personal benefits such as comfort; 3 items, α=.81, with items such as "The belief that there is one set of religious teachings that clearly contains the fundamental, basic, intrinsic, essential, inerrant truth about humanity and deity; that this essential truth is fundamentally opposed by forces of evil which must be vigorously fought; that this truth must be followed today according to the fundamental, unchangeable practices of the past; and that those who believe and follow these fundamental teachings have a special relationship with the deity." We will also use in this study a newer scale, written to be applicable to multiple religious communities: the Intratextual Fundamentalism Scale, or IFS. Sample scale items are "Everything in the Sacred Writing is absolutely true without question" and "The Sacred Writing should never be doubted, even when scientific or historical evidence outright disagrees with it." Confirmatory factor analyses led Williamson, Hood, Ahmad, Hood, and Sadiq (2007) to a 5 item scale, which are belief content free, making these items ideal for our purposes. The scale correlated significantly with other measures of religiousness and fundamentalism, showing convergent validity. Moreover, analyses by Williamson and colleagues among American Christians and Pakistani Muslims suggest cross-culturally invariant scale properties.

Research Design

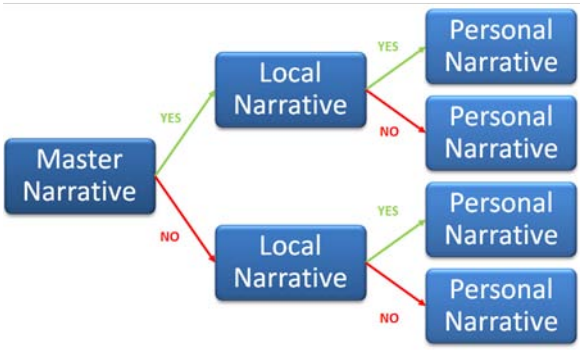
As outlined in the previous section, potential participants will begin by completing a series of religious orientation questionnaires (Altemeyer & Hunsberger, 1992, 2004; Hill & Pargament, 2003; Ji & Ibrahim, 2007; Williamson, Hood, Ahmad, Hood, & Sadiq, 2007). Only individuals who meet selection criteria will be selected to complete the fMRI or persuasion studies.

In Phases I and II, our key dependent variables include two physiological measures – fMRI and EEG, and at least three persuasive outcome effects measures – attitude (how a person feels about a target behavior – i.e., good—bad, beneficial—harmful, etc.), intention (how a person plans to behaves in the future), and behavior (how a person actually behaves). These are common outcomes and measures in persuasion research, and all measures will be developed following procedures outlined by Ajzen and Fishbein (1980) and Fishbein and Ajzen (1975). Co-PI Roberto has successfully measured and influenced these dependent variables in numerous

published studies (see biosketch for examples). Additional dependent variables in the persuasion portion of the study will include (1) story consistent belief, (2) identification with characters, (3) likelihood of engaging in critical evaluation, and (4) likelihood of engaging in counter arguments.

During both phases, the persuasion portion of the study will use a posttest-only control-group design with random assignment to the four conditions. This design controls for or allows us to assess plausible threats to internal validity (Cook & Campbell, 1963; Shadish, Cook, & Campbell, 2001). As a reminder, Phase 1 uses a 2 (master narrative/local narrative connection: yes/no) by 2 (local narrative/personal narrative connection: yes/no) withing-subjects design. Phase 2 also uses a 2 (narrative transportation: yes/no) by 2 (narrative validity: yes/no) between-subjects design. Thus, all experiments will have four groups of participants which will allow us to identify any main and interaction effects of the two independent variables in each phase of the study on our key dependent variables (e.g., attitudes, intentions, and behavior). Based on previous experiences with this and similar designs, we estimate needing approximately 80 participants per condition (or 320 per phase) to run the persuasion portion of this project and achieve adequate power.

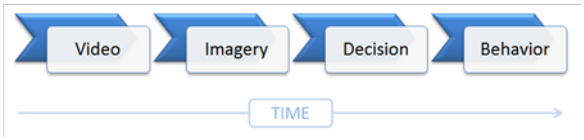
Figure 3.3 Within-subjects design hierarchy.



As stimuli for all experiments we invoke a vertical integration paradigm in which participants will watch a series of video vignettes, imagine certain details about those videos, and make decisions that should be influenced by the videos. As can be seen in Figure 3.3, the vertical integration paradigm consists of a Master Narrative (religious narrative) that either maps, or does not map, onto a Local Narrative (video vignette). Also, whether the Personal Narrative maps onto the Local Narrative or not will be manipulated through activity during an imagery phase. Each participant in the study will view videos that both map and do not map to their Master Narrative and they will also relate half of these vignettes to their personal narrative through a visual imagery manipulation.

To define our Master Narratives we will choose religion as an overarching theme. That is, both Christians and Muslims will participate in our study and we will capitalize on their religious affiliation to create video vignettes that *only* map onto one religious Master Narrative from a group but not the other group. We will define 2 Master Narratives from each religious group and then create 4 videos for each Master Narrative. As can be seen in Figure 3.4, participants will view a video lasting 1 minute. Then they will engage in an imagery phase for 30 seconds in which they will either imagine themselves in the narrative (Personal Narrative maps to the Local Narrative) or will imagine the semantic consequences of the narrative (Personal Narrative does not map onto the local narrative). Participants will then answer a series of questions about the vignette, their imagery, and their attitudes.

Figure 3.4 fMRI protocol and subject tasks.



Finally, participants will make a judgment about how much of their research payment they would like to allocate to a particular religious group (i.e., the behavioral measurements of persuasion). These are common outcomes and measures in persuasion research, all measures will be developed following procedures outlined by Ajzen and Fishbein (1980) and Fishbein and Ajzen (1975). Co-PI Roberto has successfully used these and similar measures in numerous studies in the past (e.g., Roberto, Krieger, Katz, Goei, & Jain, 2011; Roberto, Zimmerman, Carlyle, Abner, Cupp, & Hansen, 2007).

We will take four measures of behavior while participants are in the scanner (one after each series of videos). Given the number of tasks being completed in the scanner, each of these measures should be administered approximately 16-18 minutes apart.

fMRI and EEG measurements will be acquired during all these phases. While the number of subjects in the fMRI study is sufficient to determine effects for that type of data, a much larger number of participants is needed to accurately detect changes in the attitude, intention, and behavior measures. So, we opted to conduct a separate but related series of out-of-scanner studies using sample sizes consistent with previous persuasion research to help us more fully understand the relationships between our key independent and dependent variables.

The EEG and functional MRI (fMRI) task design is based on a narrative imagery design of Sabatinell et al (2006), which allows for comparison of the neural basis of narrative. The four conditions will be counterbalanced based on the design depicted in Figure 3.3. All subjects will be scanned on the same 3Tesla scanner for optimal fMRI responsivity. The Keller Center at BNI has state-of-the-art goggles and headphones to enhance the narrative experience. All scanner sequences are based on previously published parameters that have shown consistent and robust signal. Data acquisition will include the fMRI task and a high-resolution 3D T1 SPGR scan for coregistration. Data analyses will be performed using the Matlab-based analysis package SPM8[4], allowing for motion correction, coregistration, and group comparisons.

Concurrent with fMRI collection, EEG recordings will be collected with a 128-channel NeuroScan system (Quik-Cap with sintered silver/silver chloride electrodes, SynAmps2 amplifiers, Maglink EEG MRI Transmission System, and CURRY acquisition software; Compumedics USA, Charlotte, NC). The sampling rate used will be 1 ms and impedances will be maintained below 15 kΩ. Pre-processing of the EEG data will be conducted using CURRY and data analysis will be carried out with Matlab.

We will identify the Narrative Comprehension Network analyzing both the fMRI and EEG recordings with the method described by Lei and colleagues (2011). First, functional networks can be extracted using spatial independent component analysis (ICA) in both the fMRI and EEG data. Then the interactions among functional networks in each dataset will be explored using Granger causality analysis. Finally, fMRI functional networks will be matched to EEG functional networks in the spatial domain using network based source imaging. Using this method, we will be able to map the network as well as describe how it functions to support narrative comprehension. In addition to linking EEG and fMRI recordings with granger causality analysis, alternative multi-modal data analysis techniques will be examined including regression (Yang, Liu, & He, 2011), partial least squares (Martinez-Montes et al., 2004), and dynamical causal modeling (Daunizeau et al., 2011; Marinazzo et al., 2011).

In the second phase of this project, we will experimentally manipulate variables that should influence Narrative Validity as well as Transportation to make inferences about these functions in the Narrative Comprehension Network. To achieve this goal we will use the same

[4] See http://www.fil.ion.ucl.ac.uk

vertical integration paradigm from Phase 1 to assess brain functioning during narrative comprehension. Furthermore, we plan to create a 2 (Narrative Validity – Valid or Invalid) x 2 (Transportation – Yes or No) between subjects experimental design. Participants in this design will experience a series of video vignettes that have one of four forms created by the experimental design (e.g., Valid Local Narrative with Transportation). By investigating differences in brain activation within the Narrative Comprehension Network defined in Phase 1 we will be able to investigate experimentally how Narrative Validity and transportation influence vertical integration. Similar methods will be used as in Phase 1. That is, we will conduct simultaneous fMRI and EEG recording while participants are completing the vertical integration paradigm.

In the third phase of this project we will use transcranial magnetic stimulation (Magstim 200, Jali Medical Inc.) to temporarily disrupt brain regions responsible for narrative comprehension. Transcranial magnetic stimulation is a noninvasive method to cause polarization in the neurons of the brain by electromagnetic induction. Induction induces weak electric currents using a rapidly changing field. This technique allows researchers to disrupt neural networks and examine behavior. We plan to use this technique during the vertical integration paradigm in Phases 1 and 2 to examine the effects of brain disruption on narrative comprehension and persuasion. More specifically, based on Phases 1 and 2 precise brain regions comprising the Narrative Comprehension Network will be selected including those that (a) can be accessed and safely manipulated via Transcranial Magnetic Stimulation, and (b) occupy the most critical/central position in the network, and (c) are associated with the strongest effects in the Phase I and II tests.

Responsiveness to Technical Area Goals

This project addresses all three areas of Technical Area 1, making significant advances in narrative theory. Regarding Sub-goal 1, it advances a theory of *rhetorical vision* and *vertical integration*, and in particular in the justification of political violence. This unites anthropological notions of narrative's role and circulation in culture, with postmodernist attention to the meaning-making process as one centered on the individual. The vertical integration theory incorporates existing theory (such as narrative validity, cognitive narratology, etc.) and advances a mode of understanding the function of Master Narratives, Local Narratives and Personal Narratives—how historical cultural elements impact understanding of contemporary events and yield individual action. Regarding Sub-goal 2, prior work analyzing Islamist Extremist Narratives has revealed a correlation between invocation of certain Muslim master narratives, contemporary events and individual violent action (Khaled Al-Islambouli is but one example). This project advances the understanding of the neurological mechanism that connects these phenomenon. Regarding Sub-goal 3, most narrative theory proceeds on the basis of interpretive claims, rather than empirical evidence and this project provides a means of empirically testing vertical integration, narrative validity, and narrative transportation. This project advanced narrative analysis by cross-correlating these features to map the brain networks involved in comprehending narratives and how stories propagate in cognitive comprehension system.

This project addresses Sub-goals 2, 3, and 5 of Technical Area 2 by clarifying the neuropsychological roles of working memory and memory systems, emotion, identity, and theory of mind to narrative comprehension. Regarding Sub-goal 2, this research establishes the role of semantic memories and schemas for Master Narratives and furthers our knowledge of the role of identity in transporting oneself into a Local Narrative. Regarding Sub-goal 3, little

research has examined the neuropsychological role that emotions play on narrative persuasion. The current proposal aims to identify both the neural regions in the limbic system, and how they function over time, to address the role of emotional processing in strategic communication. Regarding Sub-goal 5, the vertical integration paradigm and its application in the fMRI + EEG environment will allow us to identify the neural mechanisms responsible for transportation. A priori, these mechanisms closely align with social psychological phenomena such as mental projection and theory of mind. Overall, with regard to Technical Area 2, major strengths of this proposal are the specification of the neural regions that support narrative comprehension, an explanation of how they work together to support vertical integration, and an assessment of their role in persuasive attitudes and behavioral outcomes.

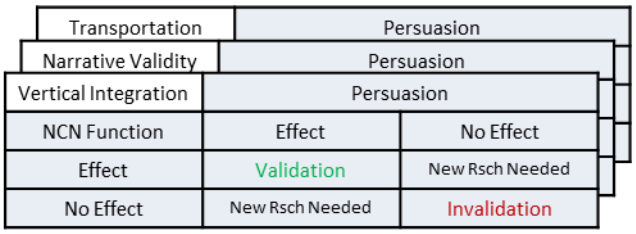
Theoretical and Practical Benefits

This project offers three theoretical and three practical benefits. Regarding the theoretical benefits, first, it tests key narrative theories in an integrated framework including narrative theory, neuroscience and classical persuasion paradigms. As we argued at the outset of this section, most narrative theory has been developed in the humanities and has not been subject to empirical testing. There is little understanding of how narrative functions on a neurological level. Where such tests exist, they identify only particular brain regions and tend not to go the extra step of testing actual attitude/behavior outcomes.

Second, this project maps not just individual regions that respond to narrative stimuli, but identifies an integrated Narrative Comprehension Network. This is important because, as we argued above, knowing which individual brain regions respond to narrative influence tells us little about how different regions work together and how their activity is temporally sequenced. Knowing this is essential both to the development of narrative brain models, and to the design of strategic communication interventions for maximum impact. Critically, the current approach argues that in order to move toward a complete understanding of the biological underpinnings of narrative comprehension and strategic communication one must understand both the structure and the function of the brain.

As a third theoretical benefit, this project promises to identify points of convergence and divergence between neurological and persuasive outcomes. As shown in Figure 3.5, this reveals cases where theoretical narrative features affect (a) both brain networks and persuasive outcomes, (b) brain networks but not persuasive outcomes, (c) persuasive outcomes but not brain networks, and (d) neither brain networks nor persuasive outcomes. Each of these conditions is interesting in itself: The first validates narrative theory empirically, the second and third indicate mismatches in theory or method, and the fourth shows where theory is off the mark. This knowledge will provide guidance to future research that can resolve the mismatches and improve narrative theory in cases where

Figure 3.5 Outcomes of converging and diverging results from fMRI and persuasion protocols.



The project also offers three practical benefits. First, it offers an understanding of how to exploit brain functions to enhance or degrade narrative persuasion. Put somewhat differently, the E-ELM and related theoretical perspectives (Moyer-Gusé, 2008) predict that when people are transported they are less likely to be aware that persuasion is occurring and will

therefore be less likely to be critical of the message (i.e. to process it peripherally rather than centrally). The design of this study will allow us to test whether or not these predictions hold true, which will have important ramifications for the narrative persuasion literature.

Second, mapping the Narrative Comprehension Network and cross-referencing the ability to manipulate both components of narrative and brain regions in order to achieve different comprehension and persuasion outcomes offers a significant advancement in understanding the cognitive processes of narrative. It is important to recognize, though, that narrative operates (as the intertwining of narrative validity and narrative transportation suggest) on multiple levels and through multiple avenues.

Another dimension that significantly influences narrative's persuasive power is its capacity to generate empathy. As Harvard-trained narrative theorist Suzanne Keen notes, "no specific set of narrative techniques has yet been verified to override the resistance to empathizing often displayed by members of an in-group regarding the emotional stakes of others" (Keen, 2010, p. 69) that are marked as members of outside that group. Identifying and developing such a technique would be valuable to DARPA and US government strategic communication efforts in general. In much of our strategic communication we face an audience strongly bonded as an "in-group" and the US is marked as the "other". Refining narrative techniques that could overcome the resistance to empathizing the American individuals and organizations would have a significant positive effect on the ability to communicate goals and shared desires. Our mapping of the Narrative Comprehension Network lays the foundation for follow-on study identifying such techniques.

Third, it affords identification of narrative techniques that could achieve effects similar to master narratives, completing the circle to Task Area 1, driving new theory. We have theorized about neural networks that undergird narrative comprehension and persuasion, proposing a largely untested model. Phases 1 and 2 of this research will identify (Phase 1) and provide strong empirical support for how the brain processes narratives, via multimodal neural imaging, in rigorous experiments guided by narrative theory. Phases 1 and 2, however, ultimately rely on correlations between brain activity and the processing of narratives, which cannot be taken as firm evidence that any neural region or network is necessary or sufficient to process a certain feature of narratives. In Phase 3, we will seek to document which brain regions are necessary for which aspects of narrative processing, via transcranial magnetic stimulation (a temporary and harmless technology which can be used to disrupt brain function in a highly localized way). Based on the results of Phases 1 and 2 of this research, using this technology, we should be able to disrupt highly selective aspects of narrative processing.

For example, if it is the case that activation in one particular neural network enables people to connect personal narratives to master narratives, by disrupting activity in that brain area, we should be able to selectively impair that specific aspect of narrative processing while holding other meaning making processes constant, effectively creating a "narrative disruptor." Not only would this be an important finding in the science of neural networks and of narrative persuasion, but would also have considerably practical and strategic importance. Mechanical disruptions of narrative processing may be, ultimately, replicated in through targeted strategic communication campaigns that approximate the narrative disruptions induced via magnetic stimulation.

III.D. COMPARISON WITH ONGOING RESEARCH

Narrative

Windelbrand (see Windelbrand & Tufts, 1901) distinguished *ideographic* approaches that value deep, particularistic analysis of unique phenomena, from *nomothetic* approaches that seek to generate general knowledge. Existing narrative theory and research comes primarily from the humanities, which favors ideographic research. While at one time there was interest in trying to define more general narrative forms (e.g. Freitag, 1863; Polti, 1921; Propp, 1968), this enterprise fell into disfavor in recent years owing to a rise in poststructuralist thought (e.g., Lyotard, 1984). As a result, there is a vast array of narrative concepts, identical terms are used in different ways by different scholars, and it is difficult to integrate them in a way that gives a coherent picture of narrative theory.

In addition concepts are applied in narrative research to produce deep interpretations of small numbers of texts, sometimes even single texts. For example, Roland Barthes' landmark analysis *S/Z* (1970) takes 220 pages to dissect the 34-page Balzac short story *Sarrasine*. It is a landmark work, and one that lays out an interpretive methodology for unpacking the meaning-making process, but at the same time is an example of deep interpretation of a single text that is difficult, if not impossible, generalize or to empirically or quantitatively verify. This attention to a relatively small body of data is even true when researchers make effort to apply more "scientific" methods to the study of narrative across texts. Bearman and Stovel (2000) applied network techniques to the study of several entries to a Nazi Party essay contest. Moretti (2005) applied cartographic analysis to a five-volume set of stories by a single author about life in the English countryside in the 18th century. The study offers significant methodological advances for literary study, but its focus on a single author's corpus does not suit more nomothetic goals.

A subset of narrative studies, cognitive narrative theory, traces its history back at least twenty-five years (e.g. Bordwell, 1985; Turner, 1991; Abbot, 1999; Hogan, 2003), and aspires to explain narrative effects in relation to advances in psychological theories of how the brain functions. Even within this field, however, relatively little work focuses on narrative comprehension (Bordwell; Branigan, 1992) and these works remain in the theoretical. Much greater attention has been paid to the affective qualities of narrative, and when this body of work draws on neuroscience, it looks to studies of emotions and feelings (e.g. Damasio, 2003, 1994; Takahashi, 2004). One area of specific neuroimaging narrative study involves mirror neurons. Drawing on studies such as Tettamanti (2005), this area of research has identified a similarity in brain response to imagining an action and actually performing the action. However, the science behind mirror neurons is currently in dispute.

Both the neuroscience studies and the cognitive science theory are used to address literary research questions in the artistic, stylistic and empathetic domains and are rarely specifically formulated to evaluate narrative functions and capacities (e.g., Zunshine, 2003). This relationship makes sense, as the field is driven by literary studies more concerned with the aesthetic and artistic workings of narrative, and not on the comprehension, persuasion, and motivation consequences.

While these studies and methodologies undoubtedly produce valuable and useful knowledge about particular texts and about aesthetic and emotional responses to narratives, they are of limited use in understanding the practical function of narrative in contemporary strategic communication. Also the idea that general cultural forms do not exist or are unworthy of study flies in the face of observed behavior by extremist groups, who use narrative to promote political

violence (see Halverson, Goodall, and Corman, 2011). Therefore this study seeks to recover the idea of general narrative forms for framing communication in the vertical integration paradigm, and relate their features to neurological responses.

Neuroimaging

Previous neuroimaging research has investigated narrative at a variety of levels of analysis including narrative comprehension, emotional influences from narrative, and the neural basis of narrative influence (i.e., persuasive effects from strategic communication). However, very little research has explored the impact of narrative according to the vertical integration theory, narrative validity, or transportation. Furthermore, no existing research has examined the relation between narrative structures, emotional responses, and persuasion. Previous fMRI research has implicated brain regions in narrative comprehension, emotional expression, and persuasion. This research has relied on reverse inference to relate brain response to cognitive function (Poldrack, 2008, 2010). Despite the importance of defining the structure and the function of a neural network, no extant research combining both fMRI and EEG exists that describes a functional network of interconnected brain regions and specifies how narrative is processed within that network.

Previous fMRI research has been conducted to understand the neural mechanisms that support narrative comprehension. This research typically compares neural activation when reading consistent and inconsistent stories. This research has specified the role of several discrete (that is, not a network of) brain regions including middle and superior temporal gyri, inferior frontal cortex, anterior temporal lobes, and dorsomedial prefrontal cortex (e.g., Yarkoni, Speer, & Zacks, 2008). Importantly, this previous research has relied specifically on cognitive theories of discourse processing to define narrative structures (i.e., coherent and incoherent stories). One shortcoming of this previous research is that it cannot speak to transhistorical master narratives that exist within a culture. By using religious master narratives, we will be able to create local narratives that map onto elaborate cultural memories held by our participants. Along these lines, a major advantage of the current approach is that it will be supported by narrative theory including aspects of vertical integration, narrative validity, and transportation.

Other research has investigated the emotional basis of narrative imagery. This work has recorded neural responses during mental imagery related to positive and negative narratives. Furthermore, this work has developed a firm foundation for understanding the role that emotional neural systems play in narrative comprehension (e.g., Sabatinelli et al., 2006). However, this prior work has failed to examine the subsequent behavioral impact of comprehending certain narrative structures (i.e., persuasion). The current work will capitalize on these prior demonstrations evaluating the brains emotional response to narrative and further it by exploring exactly how this response dictates narrative persuasion. Critically, these results will build naturally into the vertical integration theory and will help explain the neural basis of transportation and what role, if any, that narrative validity plays in narrative comprehension and persuasion.

Similar to previous narrative comprehension and emotional narrative studies, fMRI research has been conducted on the neural basis of persuasion (e.g., Falk et al., 2011). However, this research has not been closely tied to narrative theory or emotional responses. Another major advantage of the current work is that it will integrate these different research domains to provide a more accurate picture of narrative comprehension and how strategic communication can be used to manipulate emotional and cultural aspects to create persuasion.

Finally, all of these previous neuroimaging studies have been conducted using only fMRI techniques. As described earlier, these techniques provide a great deal of information about the (spatial) neural regions associated with cognitive activity. However, fMRI techniques suffer from poor temporal resolution. EEG techniques provide complimentary information about the generation of neural signals that unfold over time. That is, EEG provides a high sampling rate of electrical changes on the scalp thereby providing a much improved temporal resolution when compared with fMRI. Importantly, researchers can combine these two techniques to get high spatial (fMRI) and temporal (EEG) resolution. The research in the current proposal suggests just such an approach that will capitalize on recent developments in the multi-modal neuroimaging literature.

Persuasion

While the quantitative literature on the effects of narrative on persuasion has grown in recent years, there are still many important gaps that need to be filled. The next paragraph will briefly review a sample of the most relevant and recent quantitative studies that have been conducted in this area to date. The paragraph after that will outline the important ways the proposed study adds to or improves upon the research in this area.

Green and Brock (2000) conducted one of the most often cited set of studies in this area. In addition to developing and validating a transportation scale (a scale that will be used as a manipulation check of the proposed study), they also conducted a series of experiments to determine the effects of transportation on a variety of dependent variables. Their results suggest that transported individuals tended to have greater story-consistent beliefs and favorable evaluations of protagonists, that transported individuals found fewer false notes in the story (which is related to the concept of narrative validity that is an important independent variable in the proposed project), and that these findings were unaffected by labeling a story as fact or as fiction. Dunlop, Wakefield, and Kashima (2009) studied narrative persuasion in two health communication contexts. This study is particularly relevant to the proposed one because it was one of the few to assess intentions to perform the recommended behaviors. For example, the authors found that smokers who experienced increased transportation in response to antismoking messages reported that they would make a greater effort to quit smoking. Finally, Appel and Richter (2010) predicted and found that both need for affect and transportation moderated the relationship between a narrative message and beliefs. Particularly relevant to Phase 2 of the proposed study is that all this research found it was possible to manipulate and measure narrative transportation, a key independent variable of this phase.

The proposed study adds to or improves upon those that have been done previously it at least three important ways. First, this study will be the first to experimentally test the effects of the ASU Center for Strategic Communication's vertical integration framework on key persuasion outcome variables, including attitude, intentions, and behavior. Second, it will also be the first study to experimentally manipulate both narrative validity and narrative transportation to assess their effects on the same outcome variables listed above. Third, few previous studies of narrative persuasion assess the effects of such messages on attitudes, intentions, and behavior (which are considered to be the three main most desirable outcome variables by persuasion scholars), and instead measure the precursors of attitude, intention, and behavior change (such as beliefs). In tandem, these represent three much needed additions and improvements to the narrative persuasion literature, especially given the importance of each of these concepts to this literature.

III.E. PROPOSERS PREVIOUS ACCOMPLISHMENTS

Led by Dr. Steve Corman, the **Center for Strategic Communication** (CSC) has emerged as a leader in the study of the relationships among narrative theory, extremists' appropriation of narrative for political and ideological gains, and strategic communication interventions. Corman is a recognized international expert on government strategic communication and narrative. Other members of the team, including Corman and Dr. Trethewey have explored the communicative dimensions of armies of the future in the context of self-organizing systems in social media (e.g., the Columbian anti-FARC social movement). Trethewey, Dr. Halverson and Dr. Ruston have studied the narratives of non-violent Muslims and their potential for challenging extremist voices in both social media and local communities. Corman and Ruston participants in an ONR grant project exploring rumors and the strategic communication strategies for anticipating and quelling rumors, and Corman is a co-PI on a Minerva project studying moderate Muslim culture and communication**.** Perhaps, most directly related to the current effort, as part of a project funded by the Office of Naval Research, the CSC has developed a pragmatic theory for understanding, analyzing and decomposing extremists' narratives, generated a database of thousands of extremists' stories, made portions of this database available to others in the DARPA narrative networks program, and created protocol for scientifically analyzing extremist narratives.

The **Keller Center for Imaging Innovation** at the Barrow Neurological Institute at St. Joseph's Hospital and Medical Center is devoted to innovative, state-of-the art imaging research and development. Dr. Jim Pipe heads the Center and created Propeller Imaging, which is a platform for all GE scanners. The Center is devoted to translating all research endeavors to real-life, practical implementation. This includes developing functional MRI paradigms that answer questions that can have real impact on our world.

Narrative Theory. Dr. Scott Ruston leads the narrative theory. He holds a degree in Film and Media studies. Conversant in both narrative theory and media theory, he has published widely on how narrative intersects with media technologies such as mobile devices and social media (e.g. Ruston, 2010). A practitioner of interactive narrative, he has experience creating compelling narratives that require specific user action that reveals narrative preferences and interpretations (Stein, Ruston, & Fisher, 2009). Owing to his expertise with media production and narrative theory, he will lead the production of the stimuli materials. Importantly, Ruston is also a Commander in the Navy Reserve, with 19 years of active and reserve service including experience in Maritime Interdiction and Anti-Piracy in the CENTCOM AOR; a former commanding officer, he is assigned to the NATO Allied Command Transformation Headquarters, charged with revising NATO's identity, strategic communication and business practices. Dr. Trethewey, a co-PI on the CSC ONR project on extremists' use of narratives, is an expert on narrative, ideology, and discourse analysis, with grant and publishing experience in this area. Dr. Jeffry Halverson, a religious studies scholar, with a specialty in Islamic political theology, will be charged with ensuring the project's video stimuli provide an accurate rendering of Islamic master narratives. He will be supported in that effort by Dr. Cutrara. A produced screenwriter (Cutrara, 2010), published scholar (Cutrara, 2009) and former Jesuit priest, Dr. Cutrara's expertise in telling stories about faith and religion will help craft engaging and culturally relevant narrative video stimuli.

Neuropsychology and Neuroimaging. Dr. Gene Brewer leads the neuropsychology and neuroimaging team, with support from Drs. Adam Cohen and Leslie Baxter. Brewer is an early-

career professor at Arizona State University with considerable expertise in a variety of areas related to experimental and cognitive neuroscience and has published widely in these areas. He was a research and statistical consultant on grants from ONR (working memory training and genetics) and CDC (bully busters in middle schools) while completing his PhD at the University of Georgia. Since arriving at Arizona State University he has received an Arizona State University Institute for Social Science grant (Oscillatory Dynamics of Prospective Memory Encoding and Associative Recognition Memory) to purchase electroencephalography equipment. His expertise in cognition and cognitive neuroscience is critical for helping bridge narrative theory to its biological underpinnings. Baxter brings considerable experience as a clinical neuropsychologist and neuroimaging researcher. As Program Manager of the Human Brain Imaging Laboratory at the Barrow Neurological Institute, she uses fMRI for presurgical mapping of brain tumor and other patients, and performs imaging research studies in depression, aging and other neurological disorders. She has established a laboratory that is fully capable of developing new ways to investigate functional brain networks through imaging. For example, she recently developed a novel way to map sadness in individuals in order to examine the neuro-network associated with depression (Smith, Fadok, Liu, Stonnington, Spetzler, & Baxter, 2011). Cohen began his doctoral training in biopsychology and received his Ph.D. in social and cultural psychology--this combination of training makes him an ideal contributor to this multidisciplinary research. He is an international leader in the study of culture and religion in psychology and his presences ensures that the team has both the conceptual and methodological expertise to link key features and measures of religion and religiosity to the Narrative Comprehension Network. Cohen has been principal investigator on 5 extramural grants and co-principal investigator on 1, from funding agencies including the National Science Foundation, the Templeton Foundation, the Metanexus Institute, and the Notre Dame Science of Generosity Program. All of these grants have focused on religion, including connections to health among US and Sri Lankan Catholics, Protestants, Muslims, Hindus, and Buddhists; generosity among US, Turkish, and Irish Catholics and Muslims; and forgiveness for the Holocaust and slavery among US Jews and Blacks. This work has shown his ability to solicit student and community samples of various religious and ethnic groups, and he already has in place several connections in the Tempe area through which to solicit student and community samples of Christians and Muslims needed for this program of research.

Persuasion and Strategic Communication. The persuasion and strategic communication team is headed up by Dr. Anthony Roberto with support from a postdoctoral fellow in persuasion and social influence. Roberto has been conducting research in the area of persuasion and social influence for over 20 years. His work focuses primarily on the design, implementation, and evaluation of persuasive strategic communication campaigns, focusing primarily on public health communication campaigns. He has nearly 50 publications and has received a dozen awards for research in this and related areas. Roberto has extensive experience developing and experimentally testing the types of messages that will be included in the project. He has served as a PI or co-PI on several funded projects exploring the interactions between health-related persuasive messages and behavioral and attitudinal changes in target populations.

III.F. DESCRIPTION OF FACILITIES

Arizona State University (ASU) is the largest public research university in the United States, with a 2010 student enrollment of 70,440. In 2010 the total endowment supporting ASU is $441 million whereas the total assets of ASU Foundation worth $782 million in 2011. President Crow outlined his vision for transforming ASU into a "New American University," which has stated that ASU is in a unique position to evolve together with the city into one of the great intellectual institutions in the world. In order to build a New American University, ASU has embarked on an aggressive capital building effort. The university has been adding one million square feet of research infrastructure.

The Hugh Downs School of Human Communication is fully integrated into the ASU research infrastructure. Center of Strategic Communication (CSC) led by Dr. Steve Corman is an example of fusing advanced research, teaching and public discussion of communication. With the support from the Office of Naval Research, CSC had developed a text-analysis tool for decoding messages containing potential security threats to the U.S. In addition, in order to create a model measuring diffusion and influence of extremist narratives, the team established a database of archetypes populated with extremist narratives and counter narratives. To cope with the expanding research activities, CSC has recently added a conference room and a research laboratory.

Additionally, our research is also supported by the Barrow Neurological Institute. Its Keller Center for Imaging Innovation, which has 5,000 square feet of space dedicated entirely to imaging research, is equipped with a Philips Ingenia 3.0 Tesla scanner for this project. The center is located immediately adjacent to the clinical MRI center. Dr. Pipe, the center's director, has a strong relationship with Philips and Philips staff members who conduct on-site research at the Center. The Center has a phantom fashioned by the makers of the Alzheimer's Disease Neuroimaging Initiative (ADNI) phantom and has software allowing for calibrating structural scans across time. The Center utilizes Nordic Neurolab goggles and headphones for stimulus delivery into the scanner via a high resolution goggles and headphone system that is completely MRI compatible.

In addition, the Human Brain Imaging Laboratory is situated in a 5-room suite with 1,200 square feet of space. The laboratory has several networked Mac/Linux workstations linked to RAID and other storage systems, as well as the MRI network and other ASU lab networks. Further, Post-processing tools, such as Matlab, SPM8, ANALYZE, image reconstruction software, and various image conversion utilities are installed in these computers.

III.G. DETAIL SUPPORT

Dr. Steven Corman, the Principal Investigator, leads and monitors the research project team, and coordinates all the areas to achieve the research goals based on the design of this proposal. Co-Principal Investigators will contribute expertise as assigned in the organizational chart, but will also contribute expertise as needed to support and ensure the success of the entire project. Co-Investogators will contribute expertise in specialized areas.

Under Dr. Corman's direction, there are 4 teams formed to drive to the project success. Dr. Scott Ruston heads up the Narrative Theory Team and direct stimulus production area with Dr. Angela Trethewey, Dr. Jeffry Halverson and Dr. Daniel Cutrara. Dr. Gene Brewer leads the neuropsychology and neuroimaging team to design and conduct the neuroimaging experiments and analyze the results. Dr. Antony Roberto heads the Persuasion and Strategic Communications team to design and conduct the persuasion experiments and analyze the results. Dr. Cohen also leads subject recruiting and qualification.

The project team and the Barrow Neurological Institute (BNI) work hand-in-hand for the purposes of conducting multi-modal (fMRI + EEG) scans using research facilities that BNI maintains. Arizona State University's Office for Research and Sponsored Projects Administration (ORSPA) is prepared to enter into a sub-award agreement with BNI for this proposal. ORSPA will administer the sub-award on behalf of the ASU Principal Investigator and University in accordance with relevant programmatic, fiscal, and administrative requirements. Arizona State University agrees to ensure all applicable policies, rules, and regulations, including those regarding ethical conduct for research, are adhered to in carrying out the ASU effort.

An experienced project manager (PM) will be hired to enhance the coordination activities among the project teams. The PM will also ensure that activities comply with budget and expenses monitoring, meet project goals and fulfill stated tasks, and conduct progress reporting under Arizona State University research administration rules and regulations.

In addition, ASU plays a very supportive role to the project too. Communication among Investigators is very crucial. Day-to-day communication will be available through the ASU email system. Data collected will be stored in computers designated for project use only and backup data will be stored in a university-wide secured file sharing system. Each team will hold a meeting weekly to review issues and achievements past week and set goals for the coming week. They will bring any important information or issues back to a project-wide regular biweekly meeting, other members will be updated and offer feedback and suggested resolutions to issues.

III.H. COSTS, SCHEDULES, AND MILESTONES

Phase 1 - April 2012 – September 2013

Tasks \ Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Calendar Year	2012 Q2			2012 Q3			2012 Q4			2013 Q1			2013 Q2			2013 Q3		
Phase I																		
1.1. Startup tasks																		
1.1.1.Hire staff																		
1.1.2.Design experiments																		
1.1.3.Human subjects																		
1.2. Stimulus videos																		
1.2.1. Design narrative stimuli																		
1.2.2. Pretest narrative stimuli																		
1.2.3. Video preproduction																		
1.2.4. Video production																		
1.2.5. Pretest videos																		
1.3. Persuasion (separate from scans)																		
1.3.1. Pretest persuasion protocol																		
1.3.2. Run persuasion protocol																		
1.3.3. Analyze persuasion protocol																		
1.4. Multi-modal imagaing (40 subjects)																		
1.4.1. Pretest scanning protocol & recruit																		
1.4.2. Run scans																		
1.4.3. Analyze Scans																		
1.5. Write results																		
1.5.1. Knowledge Capture / Progress documentation																		
1.5.2. Report writing																		
1.6. Program Management																		
1.7. Travel																		

Milestones - Project team will conduct quantitatively validate to the narrative paradigm, record multi-modal neuroimaging responses to narrative, and quantify behavioral outcomes. $2,303,195.

- Startup task April 2012 – July 2012 $340,981
    - Complete all project preparation, experiment design and human subject application by July 2012 (Month 4)
- Narrative Stimuli April 2012 – January 2013 $657,495
    - Design and pretest narrative stimuli – internal written report will be ready by July 2012 (Month 4).
    - Video preproduction preparation, production and pretest videos – internal written report will be available by January 2013 (Month 10).
- Persuasion Protocol January 2013 – August 2013 $253,202
    - Pretest, run and analyze persuasion protocol testing – One or more completed manuscripts will be submitted to conferences and for publication by August 2013 (Month 17).
- Multi-modal imaging March 2013 – August 2013 $266,051
    - Pretest, run and analyze scanning protocol testing – Date collected will be analyzed by August 2013 (Month 17).
- Knowledge Capture and Write Results April 2012 – September 2013 $475,313
    - Conceptual breakthroughs and methodological refinement are prepared for publication and conference presentation. Phase One progress report will be produced by September 2013 (Month 18).
- Monthly progress report from Month 1 to Month 18 April 2012 – September 2013 $224,527

- Attend Kick-off meetings, PI annual meetings and conferences April 2012 – September 2013 $85,626

Phase 2 – October 2013 – March 2015

Tasks \ Month	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Calendar Year	2013 Q4			2014 Q1			2014 Q2			2014 Q3			2014 Q4			2015 Q1		
Phase II																		
2.1. Design validity and transportation manipulations																		
2.1.1. Design																		
2.1.2. Pretest																		
2.2. Multi-modal scanning 160 scans w/ persuasion questions																		
2.2.1.Prestest scanning protocol																		
2.2.2.Run scans																		
2.2.3.Analyze scans																		
2.3. Persuasion tests																		
2.3.1. PPrestest persuasion protocol & recruit																		
2.3.2. Run persuasion tests																		
2.3.3. Analyze results																		
2.4. Write results																		
2.4.1. Knowledge Capture / Progress documentation																		
2.4.2. Report writing																		
2.5. Program Management																		
2.6. Travel																		

Milestones - Project team will focus on the derived aspects of narrative validity and transportation to influence vertical integration and persuasion, with directed tests of the effects on neuropsychological processing. $1,835,062

- Design validity and transportation manipulations October 2013 – November 2013 $84,576
    - Perform preproduction and postproduction formative research by November 2013 (Month 20).
- Perform Multi-modal scanning December 2013 – February 2015 $730,032
    - Recruit subjects, pretest, run and analyze EEG and FMRI imaging scanning. Group analyses will be performed by February 2015 (Month 35)
- Perform Persuasion Tests December 2013 – October 2014) $373,559
    - Recruit subjects, pretest, run and analyze results in according with EEG/fMRI by October 2014 (Month 31).
- Knowledge Capture and Write Results October 2013 – March 2015 $350,646
    - Conceptual breakthroughs and methodological refinement are prepared for publication and conference presentation. Phase Two progress report will be produced by March 2015 (Month 36).
- Monthly progress report from Month 19 to Month 36 October 2013 – March 2015 $236,472
- PI annual meetings and conferences October 2013 – March 2015 $59,777

Phase 3 – April 2015 – September 2016

Tasks \ Month	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Calendar Year	2015 Q2			2015 Q3			2015 Q4			2016 Q1			2016 Q2			2016 Q3		
Phase III																		
3.1. Obtain TMS equipment, configure & train																		
3.2. Generate hypotheses to be tested by selectively interrupting particular brain regions																		
3.3. Design experiments																		
3.4. Run experiments to test effects on persuasive outcomes																		
3.5. Analyze results																		
3.6. Write results & final report																		
3.6.1. Knowledge Capture/Progress documentation																		
3.6.2. Report writing																		
3.7. Program Management																		
3.8. Travel																		

Milestones - Selective alter aspects of narrative structure and brain functioning will be chosen via Transcranial Magnetic Stimulation (TMS) to induce or disrupt selective features of narrative processing, to provide the strongest possible inferences about the operation of the Narrative Comprehension Network. $1,943,364

- Obtain TMS hardware and set up April 2015 $179,943
  - By June 2015 (Month 39), TMS will be trained and the team will be enabled to start experiments
- Generate hypotheses April 2015 $141,058
  - By June 2015 (Month 39), a hypothesis is articulated when TMS hardware is ready.
- Design experiments June 2015 $186,948
  - By August 2015 (Month 41), experiment design will be set.
- Conduct experiments September 2015 $380,294
  - By April 2016 (Month 49), run experiments according to the design and hypothesis set in 3.2 and 3.3
- Analyze experiment results April 2016 $370,726
  - By August 2016 (Month 53), data collected during 3.4 will be all analyzed.
- Knowledge Capture and Write Results April 2015 – September 2016 $347,113
  - Conceptual breakthroughs and methodological refinement are prepared for publication and conference presentation. Phase Three progress report will be produced by September 2016 (Month 54).
- Monthly progress report from Month 37 to Month 54 April 2015 – September 2016 $252,422
- PI annual meetings and conferences April 2015 – September 2016 $84,860

IV. A. BIBLIOGRAPHY

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November 15, 2011

Steve Corman
Hugh Downs School of Communication
[redacted]

Dear Dr. Steven Corman,

The following proposal has been evaluated and identified as excluded from review based on numbers *56.118 and *46.118 of the Code of Federal Regulations (56 CFR and 45CFR46) which provides for grants where definite individual project specific details for human subject participation are not yet formalized.

You are reminded that no human subjects may be involved in any project supported until the project has been reviewed and approved by the IRB, as required by Federal Regulations and ASU Policy.

Principal Investigator:	Steven Corman
Title of Grant:	Toward Narrative Disruptors and Inductors: Mapping the Narrative Comprehension Network and its Persuasive Effects
Funding Source:	Defense Advanced Research Projects Agency (DARPA)
HS Number:	1111007093
Institution:	Arizona State University

This institution has an approved Federal Wide Assurance (FWA) 9102 on file with the Office of Human Research Protections.

[redacted]

Susan Metosky
IRB Administrator

September 2011

Countering Violent Extremism

SCIENTIFIC METHODS & STRATEGIES

TOPICAL STRATEGIC MULTI-LAYER ASSESSMENT (SMA) MULTI-AGENCY AND AIR FORCE RESEARCH LABORATORY MULTI-DISCIPLINARY WHITE PAPERS IN SUPPORT OF COUNTER-TERRORISM AND COUNTER-WMD

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UNDERSTANDING THE ROLE OF NARRATIVE IN EXTREMIST STRATEGIC COMMUNICATION[1] (STEVEN R. CORMAN)

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It seems that everyone is talking about narrative these days. The Global Language Monitor (2010) listed it as the top political buzzword of the last U.S. presidential campaign. Secretary of Defense Robert Gates has expressed concerns about the negative narrative surrounding the war in Afghanistan (Wallace, 2010). The Chairman of the Joint Chiefs of Staff has talked about the need to "supplant the extremist narrative" (Mullen, 2009, p. 4). In recent congressional testimony, Daniel Benjamin (State Department Counterterrorism Office, 2011) described delegitimizing extremist narratives as one of the top priorities of the Office of Coordinator for Counterterrorism.

Yet, for all of this interest in narrative, there is little consensus about what it is and how it is used. My colleagues and I at the Consortium for Strategic Communication have been conducting a research project on Islamist extremists' use of narrative for the past two years, focused on developing a pragmatic perspective on narrative that is useful for strategic communicators in the government and military. In this piece I begin by outlining the narrative framework we have developed. I illustrate the basics with examples from U.S. culture because they will be familiar to many readers. But then I turn to some findings from our research on how al Qaeda and other extremist groups use narrative for persuasive purposes. I conclude with some implications for how extremists' narrative efforts can be countered.

What is Narrative?

There is little consensus in the academic literature about distinctions between concepts like story, narrative, and discourse. Most work in this area is done in the humanities, which has a tradition of individual scholarship and favors unique analysis over generalization. It is not far from the truth to say there are as many theories of narrative as there are theorists. This sea of competing ideas and definitions is of little practical use to non-academics. Practitioners, for their part, have the opposite problem: They tend to use ideas like story and narrative interchangeably, glossing over what are important (and useful) distinctions.

For a pragmatic perspective on narrative, we can begin by distinguishing story from narrative. A *story* is a sequence of events, involving actors and actions, grounded in desire (often stemming from conflict) and leading to an actual or projected resolution of that desire. An example of a story in American history is the "midnight ride of Paul Revere." The desire was to protect the Patriots from a surprise attack by the British Army. The sequence of events involved Revere and Dawes riding from Boston to Lexington, warning Patriots along the way, and ultimately delivering word of British movements to Adams and Hancock. Meanwhile, colleagues hung lanterns in the Old North Church

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to convey the same message as a backup, in case the riders were captured. The resolution is that, because of the warning, the militia was able to force the retreat of the British to Concord.

Though some stories are unique, they more typically follow *story forms*, standard patterns on which stories may be based, defining typical actors, actions, and sequences. An example of a story form is the rags-to-riches story and it underlies films as different (in content and quality) as *Citizen Kane*, *Slumdog Millionaire*, and *Beverly Hills Chihuahua*. Revere's ride is an example of a *deliverance story*: A community is menaced by a threatener, who is countered by the efforts of a champion who repels the threat and restores the community to normality. Often, story forms also employ *archetypes* like the champion, standard characters expected in stories to have or demonstrate standard motives and behaviors in particular situations.

A *narrative*, then, is a system of stories that share themes, forms, and archetypes (Figure 1). Every story in a narrative need not have exactly the same characteristics; however, they relate to one another in a way that creates a unified whole that is greater than the sum of its parts. So for example, there is a narrative about the American Revolution that includes Revere's ride, as well as other stories of political decision-making, decisive battles, hardship, British treachery, etc. Taken as a whole this ensemble has deep meaning for citizens of the United States.

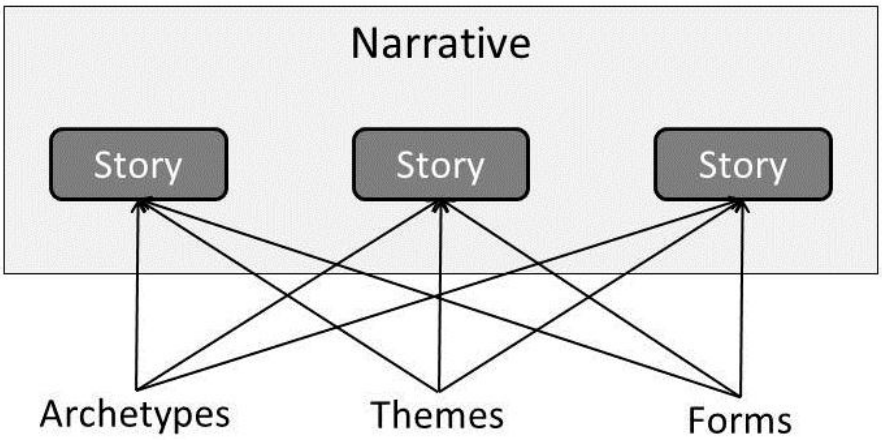

Figure 1. Narrative Elements

Some narratives, whose stories are widely known in a culture and consistently retold over time, rise to the level of *master narratives*. The American Revolution is an example. Master narratives are so deeply engrained that they can be invoked by words and phrases without actually telling the stories that comprise them. These references automatically call up the narrative for an audience. Consider the recent use of "tea party" to describe a political interest group in the United States. Using this phrase as a label invokes not only a particular well-known story from the Revolution, but the values, actions, and archetypes that are part of the larger narrative, and associates them with the modern political group.

As the difference between a narrative and a master narrative implies, narratives can apply at different levels of specificity. Betz (2008) refers to this as *vertical integration*, and I adapt his idea here. There are

other master narratives in U.S. culture besides the Revolution. Other examples are the: The Civil War and Reconstruction, the Industrial Revolution, World War II, the Cold War, the Civil Rights Struggle, 9/11, and so on. The master narratives in this collection knit together to form what Bormann (1972) called a *rhetorical vision*:

> Once such a rhetorical vision emerges, it contains dramatis personae and typical plot lines that can be alluded to in all communication contexts and spark a response reminiscent of the original emotional chain. The same dramas can be developed in detail when the occasion demands to generate emotional response (p.398).

Therefore, the rhetorical vision contains a stock of values, morals, story forms, archetypical actors that can be used in narrative action.

Moving towards greater specificity, master narratives can be used to create *local narratives*, about events in particular times and places. The "tea party" seeks to do just this by invoking values of the Revolution in modern political debate. Furthermore, individuals have their own life stories, or *personal narratives*, through which they can project themselves as characters in local narratives. This happens, for example, when a "tea partier" attends a local rally or protest.

One more question remains before turning to the case of Islamist extremist narratives: Why are narratives important? Because they present an alternate form of rationality. Whereas rationality is typically conceived as something that flows from facts and logical reasoning, narrative rationality is based on whether an audience can see positive outcomes from a story and can align it with their values (Fisher, 1987). Narrative rationality can trump logical reasoning (for example, in the case of conspiracy theories) because it is an alternate way of thinking about the world that has close connections with desires and emotions, and is deeply involved in how we make sense of events in everyday life (Campbell, 1991).

Having outlined this pragmatic framework on narrative, I now examine the use of narrative by Islamist extremist groups for strategic communication purposes. Our research shows that they have a definite rhetorical vision composed of a number of master narratives, and consistently make use of these resources to persuade their audience to support or tolerate their actions.

Islamist Extremism and Narrative

In a recently published book (Halverson, Goodall, & Corman, 2011) my colleagues and I outlined 13 master narratives of Islamist extremism. We discovered these by examining several hundred public statements, video transcripts, and texts from al Qaeda and other Islamist extremist groups. We observed that members of these groups consistently referred to certain stories from religious texts and Muslim history to interpret events, justify their actions, and influence behavior of their followers (and would-be followers).

While all of these master narratives make up the extremists' rhetorical vision, three in particular are heavily used—and frequently used together—in their texts. The most common is *al-Nakbah*, Arabic for "the catastrophe." It tells the stories of the loss of Palestine to Israel in 1948. However, the narrative goes beyond the immediate loss to the Palestinians. It also invokes stories of Jerusalem being the original point of orientation for prayer in the time of the Prophet, home of the sacred al-

Quds Mosque, and greater Palestine being the burial place of earlier prophets and patriarchs of the faith. It is also the site of a miraculous Night Journey and Ascension to Heaven by Muhammad.

Illustrating the vertical integration model described previously, local narratives are systematically connected to this master narrative. Here Shaykh Hamid al-Ali (al-Ali, 2010) of Kuwait tells stories to accuse Arab governments of complicity in deepening the catastrophe:

> Let us take a quick look at some events in history. The first decade was marked by the selling of Palestine in the so-called Al-Nakbah, after which the Zionist entity was declared, and then was sold the biggest area of Palestine and some Arab lands around it in the so-called Al-Nakbah. The decade after, Egypt was sold to the Zionists in the accord of humiliation and insults known as "Camp David," which was followed by the sale of the blockade of enmity with the Zionists, with the opening of the first embassy for them in an Arab country. This was followed by the most ignoble deal in the history of Palestine, the Oslo [Accord]. Thus, they kept saying that they would never give up Jerusalem in public, but in secret they were racing to see who would get the prize of historical humiliation by selling it to the Zionists. Thus, the deterioration of the Arab system started selling Jerusalem in all its parts, in addition to the judaization of its landmarks, even the ones around the Al-Aqsa mosque.

The story form behind the *Nakba* is deliverance (described previously). But because the narrative is unresolved, it implicitly calls for a champion to step forth and restore the community. Shaykh al-Ali plays on this structure by predicting the ultimate defeat of the "Zionist entity" through steadfast efforts of the *ummah* (worldwide Muslim community).

The second most common master narrative invoked by the Islamist extremists is the *Crusaders*. This refers, of course, to stories of the Christian invasions of the Middle East in the 10th through 12th centuries. It treats an earlier invasion by the Mongols as a parallel case. The common *Invasion* story form involves a colonizing force that invades and subjugates a community until it is repelled by the actions of a champion.

Again, this master narrative is regularly invoked to contextualize local events and persuade people to assume the role of champion or support other champions. Here is a portion of a statement released by al-Qaeda in the Lands of the Islamic Maghreb (AQLIM, 2011) in January 2011 to those conducting the revolt in Tunisia:

> The tyrant, Ben Ali, is one of the pharaohs and most dangerous criminals of our time. He was appointed by the crusaders, on behalf of them, in our countries to slaughter the ummah and to deviate it from its religion. … The battle that you are fighting today is not isolated from the general battle waged by the whole Islamic ummah against foreign and local enemies. The battle, intended to uproot oppression, maintain justice, liberate the Muslim lands from the conquerors, dismiss their apostate quislings, and implement the Shari'ah is one battle. Neither freedom nor justice will be achieved without an Islamic government, which cares for the people's rights, protects honors, spreads justice, and implements the Shura [an Islamic principle upon which a ruler is selected by a high committee of scholars and he consults them in all matters]. This government will only be existent by performing jihad against the crusaders and the Jews, and by toppling their agents, the treacherous rulers like Ben Ali, Bouteflika, Muhammed VI, Al-Qaddafi, and others.

This AQLIM statement also invokes the third most common master narrative of Islamist extremism, the *Pharaoh*. It is based on a story from the Qur'an about a confrontation between *Musa*

(Moses) and the Pharaoh of Egypt. The story is similar to that in the Old Testament, but ends with God delivering Divine retribution by drowning the Pharaoh and preserving his body as a warning to future tyrants (and anyone else) who would doubt His sovereignty. The *Pharaoh* master narrative is based on the ancient story form of conflict with God. It is invoked to contextualize local events (as in the AQLIM statement) and encourage the audience to resist the tyrant and/or take on the role of God's agent to help smite him.

There could hardly be a better illustration of the vertical integration principle than the case of the Sadat assassination. In October 1981 President Anwar Sadat of Egypt was killed by military personnel during the Suez Canal victory parade. The squad that killed Sadat was led by Lt. Khalid al-Islambouli, who upon shooting the President shouted, "I killed the Pharaoh!" and repeated the same claim at his trial (Beattie, 2000). So here is a case where a master narrative drawn from an extremist rhetorical vision, based in the Qur'an, provided framing for local narratives about Sadat's corruption. Influenced by these, Lt. al-Islambouli cast himself in the role of the agent of God in his personal narrative, and led the plot to kill Sadat.

The pharaoh label is usually applied to "apostate" leaders in Muslim countries, as in the example above. However, it is also applied to leaders elsewhere who the extremists consider corrupt or tyrannical. Figure 2 shows a poster that circulated during President Obama's trip to Indonesia in October 2010. U.S. born Yemeni extremist Anwar al-Awlaki made similar allusions in an interview in 2010 about Obama's Cairo speech: "Is it a blessed hour to welcome Obama, the commander of today's crusade, and the leader of the war against Islam, and the Pharaoh of the age?" (al-Awlaki, 2010).

Figure 2. Poster of President Obama circulated during his recent trip to Indonesia

The *Nakba*, *Crusader*, and *Pharaoh* master narratives are only three among the 13 we have identified (albeit the most commonly used) and there may be more that we have not yet identified. Nonetheless, they provide a good picture of the rhetorical vision of Islamist extremists. They see the world as a dangerous place for Islam and Muslims. Enemies stand ready to invade, subjugate, and humiliate, as they have done repeatedly throughout history. They are chipping away at the land promised to Muslims by God. Corrupt leaders collude with the Crusaders and also oppress their people. In many cases the narratives are unresolved, so the situation implicitly cries out for Muslims to come forward as champions to rectify the injustice. This simultaneously allows the extremists to position themselves as the champions, and implies that those on the sidelines should join them.

It is important to point out that not all local narratives are based on master narratives, which grow from local narratives over time. For example we have detected a story form we call *victorious battle*, which is the basis for reports like this one (ar-Rahma, 2010):

> Mujahidin Imarah Islam Afghanistan attacked a military base in Hisarak district of Nangarhar province with heavy weapons on Tuesday. Reports indicate about 22 mortars landed on the base and causing a fatal loss enemy side.

Scores of stories with this same basic structure are published on an ongoing basis by ar-Rahma and other sites like it in South Asia and the Middle East. They make up a narrative projecting the mujahideen in Afghanistan as an effective force that is winning battles against the Afghan government's military and its Western allies. These stories do not usually invoke any master narrative. Yet they seem to be intended to enhance recruiting so they are important nonetheless.

Contesting Extremist Narratives

There are two approaches for contesting or countering the kinds of narratives described above. The first applies to stories in general. Fisher (1987) describes two aspects of narrative rationality. *Narrative coherence* is the tendency to assess communications based on whether their stories (or implied stories) make sense structurally. This considers factors like whether the sequence of events is consistent, the actors and their actions are plausible, and the resolution happens as it should. *Narrative fidelity*, on the other hand, involves assessing whether the stories "ring true," whether they are plausible with respect to the experiences and values of the audience.

Stories like those of the victorious battle narrative might be challenged on either of these grounds. The stories are incoherent because taken as a whole they indicate rates of loss for the extremists' opponents that are wildly implausible and inaccurate. Preliminary results from our review of these stories indicate that they depict the United States as losing approximately a half-battalion per month in the Afghan conflict.

A fidelity basis for undermining the battle stories is that "mujahideen operations" frequently kill innocent Muslims, accounting for as much as two-thirds of civilian deaths in Afghanistan (UNAMA, 2010). What kind of champion kills the people be is trying to save? This seriously violates both the social and religious values of the audience. The extremists realize this because they expend an inordinate amount of effort developing strategic communications to making excuses for such casualties.

Narratives that draw on master narratives are a special case in terms of contesting narratives. They gain coherence and (especially) fidelity from a comparison between a present-day, local situation and the stories of the master narrative. The comparisons depend on a class of techniques known as observational arguments (Smith, Benson & Curley, 1991), including arguments from sign, analogy, and parallel case. The technical differences between these forms are not important for the present purposes. It is enough to know that they rely not on deductive logic, but rather on observing similarity between a known situation and a target situation, and reasoning from the known to the target.

Usama bin Laden made an argument from parallel case in 2002. He invoked the Crusader master narrative (as well as the Soviet defeat in Afghanistan, another invasion narrative). Based on this he projects ultimate defeat for the U.S.:

> If you refuse to listen to our advice, then be aware that you will lose this Crusade Bush began, just like the other previous Crusades in which you were humiliated by the hands of the Mujahideen, fleeing to your home in great disgrace. Your end will be like the soviets that fled from Afghanistan after suffering a colossal military and economic defeat. This is our message to them answering their inquiries and Inshallah the victory will be ours.

There are two options for refuting observational arguments, both aimed at disrupting the observation of similarity between the known and target situations. With this link broken, the story being told about the target loses its coherence and/or fidelity. First, one can identify aspects of the observation that do not make sense—in other words, find reasons why the known and target situations are not as similar as they are being made out. The bin Laden argument above might be questioned on the basis of dissimilarity between the U.S. case and the actual Crusades. The U.S. invasion was not sanctioned by the Catholic Church, was not designed to capture Holy Lands, and participants were not promised absolution of sins for participating.

Second, one can advocate a different or better interpretation for the target, i.e. relate it to a different known situation. Here the Iraq war might be offered as an alternative target for bin Laden's Afghanistan analogy. Though U.S. forces had a difficult time in Iraq, in the end it has not suffered a "colossal military and economic defeat." On the contrary, it prevailed against groups affiliated with al Qaeda, turning the local population against them. Today the U.S. is preparing to withdraw all combat forces from the country as it said it would do, undermining claims that it is a Crusader aiming to permanently colonize the country. Based on the alternate analogy, we can expect that the U.S. will also turn Afghans against bin Laden and his associates, and eventually leave that country victorious.

Conclusion

Narratives are powerful resources for influencing target audiences. They offer an alternative form of rationality deeply rooted in culture, which can be used to interpret and frame local events and to strategically encourage particular kinds of personal action. Analyzing and developing an understanding of extremist narratives can make U.S. strategic communication more effective in two ways. First, it affords a better understanding of what the extremists' rhetorical tactics are and why they are often very effective. When we ask, "How has one man in a cave managed to out-communicate the world's greatest communication society?" (Kishore Mahbubani, quoted in Halloran, 2007, p. 5), the answer is "effective use of narrative." Second, by better understanding how narrative is used for argumentation, we can see options for contesting the arguments by using comparisons and alternative framing.

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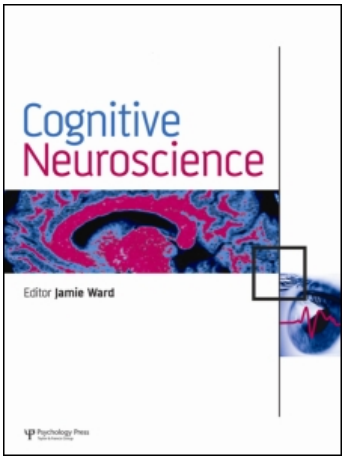

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On the role of episodic future simulation in encoding of prospective memories

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On the role of episodic future simulation in encoding of prospective memories

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Simulating future events is dependent on a similar neural circuitry to that which supports retrieving contextual information about past events. The current study examined two novel predictions from recently reported episodic future simulation studies. Prospective memory is broadly defined as the usage of episodic memory processes to encode and retrieve intentions at some appropriate moment in the future. The results from two experiments are consistent with the idea that episodic future simulation is an important component of encoding prospective memories (i.e., forming intentions for the future). Furthermore, the results necessitate further neuroscientific investigations of encoding prospective memories and additionally suggest that current theories of prospective memory need to be updated to fully account for our ability to encode, retrieve, and fulfill intentions for the future.

Keywords: Prospective memory; Episodic memory; Future simulation.

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INTRODUCTION

Memory is essential for planning and coordinating activities that will need to be carried out in the future. Only recently have researchers begun to appreciate the critical role that retrospective memory processes play in fulfilling such intentions (Marsh, Cook, & Hicks, 2006). By this account, the realization of delayed intentions relies on episodic memory, and recent theorizing has attempted to elucidate the conditions under which attentional processes are necessary for the retrieval of these declarative memories (Einstein et al., 2005; Marsh & Hicks, 1998; Smith, 2003). These declarative representations have been labeled event-based prospective memories to reflect a person's reliance on processing some constellation of perceptual cues to elicit an appropriate action in the future. Most research dealing with event-based prospective memory has investigated how cues are detected in the environment and how appropriate actions that are associated with these cues are retrieved from memory. The present study capitalized on recent neuroimaging research dealing with episodic future simulation in order to test two novel predictions about how people use episodic memory to *encode* event-based prospective memories. More specifically, we believe that such memories consist of a simulated future context, perceptual cues that may occur in that context, and a target action to carry out at the moment in the future in which the cue is encountered.

To study event-based prospective memory, researchers have developed a paradigm that resembles real-world scenarios in which people must remember to perform a specific action at an appropriate moment in the future. Imagine forming the intention to give a colleague a message when you see them at work. When you encounter your colleague later that day, you may or may not remember to give them the message. To simulate this scenario in the laboratory, participants are typically engaged in an ongoing task (e.g., lexical decision task) in which event-based prospective memory cues infrequently occur (e.g., animals; Marsh, Hicks, & Watson, 2002). When

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participants detect a cue in the ongoing task they must retrieve their intention and make a target response (e.g., press the slash key). This basic paradigm has been instrumental in clarifying the attention and retrospective memory processes that are necessary for successful event-based prospective memory (for a review see McDaniel & Einstein, 2007). Moreover, this basic paradigm has been useful for distinguishing prospective memory from retrospective memory.

Prospective memories differ from retrospective memories in several important ways (Marsh et al., 2006). First, prospective memories have a dual nature in which intentions consist of not only a retrospective component, but also a prospective component (Einstein & McDaniel, 1990). In many respects the prospective component of an intention is what separates it from other retrospective memories. To wit, the association of a target action to some type of cue is what distinguishes a standard retrospective memory from an event-based prospective memory. Second, intentions about future activities reside in memory at an above baseline level of activation (i.e., the intention superiority effect). This superiority effect is typically demonstrated when intention-related information is processed differentially when it is encountered in the context of some ostensibly unrelated ongoing task (Goschke & Kuhl, 1996; Marsh, Cook, Meeks, Clark-Foos, & Hicks, 2007). Third, prospective memories require some level of self-initiated processing to be retrieved whereas retrospective memories sometimes do not (Craik, 1986). In cases where ongoing task processing draws attention away from relevant features of the event-based cues, people may need to allocate preparatory-attentional resources for monitoring for those features in order to successfully fulfill delayed intentions (Einstein & McDaniel, 2005; Marsh & Hicks, 1998; Smith, 2003). Fourth and finally, prospective memories consist of two contextual representations whereas retrospective memories typically consist of only one. That is, when people encode a prospective memory they not only have a mnemonic representation of that original encoding episode, but they also simulate a representation of the future in which event-based cues might be noticed and the target action might ultimately be carried out. This *future-simulation* ability is related to the constructive nature of episodic memory and is quite important for the realization of delayed intentions (Atance & O'Neill, 2001).

A unique feature of the human memory system is its ability to reconstruct and re-experience past events (Johnson, 2006; Tulving, 1983). Our declarative memory system is flexible, and as a result we are also able to construct and experience future events before they occur (Atance & O'Neill, 2001). Recently, research has examined the neural network responsible for mental time travel (Addis, Wong, & Schacter, 2007; Buckner & Carroll, 2007; Schacter & Addis, 2008; Szpunar, Watson, & McDermott, 2007). The findings from these studies indicate that people recruit similar neural structures when they remember the past as when they envision the future. Theoretically, this episodic-memory network plays a role in recapitulating perceptual context and these cortical–subcortical structures are critical for both remembering the past and envisioning the future (Okuda et al., 2003). Thus, episodic information is useful for creating representations of event-based prospective memories which are to be carried out in the future.

THE CURRENT STUDY

The current study tested two novel predictions, using standard event-based prospective memory paradigms, which were derived from neuroimaging evidence from episodic future simulation studies. The first prediction was that the strength of the association between the event-based cues and the ongoing task context in which they will occur influences their likelihood of detection. Szpunar and McDermott (2008) demonstrated that participants report stronger subjective experiences of the quality of their representations of the future when they are imagined in a familiar context (e.g., their home vs. a jungle). Thus, when people encode an event-based prospective memory they presumably associate potential cues to some expected context. As such, when the cue-to-context association is weak, people should have a lower likelihood of detecting event-based cues.

The second prediction from future-simulation studies was that episodic memory could be used to create more elaborate representations of a future context in which an intention would be fulfilled. D'Argembeau and Van der Linden (2004, 2006) found that people report envisioning future events in similar contexts as they have experienced past events. They have also found that individuals who have higher visual imagery capabilities report stronger phenomenological experiences while future-looking. Based on these findings, more elaborate event-based prospective memories should have higher likelihoods of being fulfilled. The following experiments tested these two predictions using a standard event-based prospective memory paradigm in which participants completed a lexical decision task after forming the intention to make a special response whenever they detected a rarely occurring event-based cue (e.g., any animal word).

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EXPERIMENT 1

Participants

Undergraduate students from the University of Georgia volunteered in exchange for partial credit toward a research appreciation requirement. Each participant was tested individually in sessions that lasted approximately 25 min. A total of 90 participants were randomly assigned to one of three between-subjects conditions. Each group differed in the level of encoded association between the prospective memory intention and the ongoing task.

Materials and procedure

The parameters of the ongoing lexical decision task were nearly identical to those used by Marsh et al. (2002). There were 210 lexical decision trials, with equal numbers of valid English words and pronounceable nonwords. The 105 valid words were chosen from the Kučera and Francis (1967) norms. The nonwords were made in house by changing one or two letters of 105 different, valid English words to make them pronounceable nonwords. Word and nonword responses were made by pressing either the F or J (home) key on the keyboard. The ongoing task was self-paced and each trial began with a "waiting" message. Participants were instructed to press the *space bar* with their thumb to initiate the following letter string presentation. After pressing the *space bar* a fixation point appeared onscreen for 250 ms, and then the letter string appeared in the center of the monitor at the same place the fixation point had occupied. Eight event-based prospective memory cues occurred every 25 trials. The event-based cues were randomly assigned to each of these eight positions anew for each participant. In addition to completing the lexical decision task, participants were also instructed to respond to animals in all three conditions, with the only difference between groups being the encoding conditions of the intention to make a special response to animals.

In the no-association condition, participants were instructed to press the slash key anytime that an animal occurred during the experiment immediately after they signed informed consent. Importantly, at this point in the experiment the participants in the no-association condition were not aware that the event-based cues (i.e., animal words) would occur in a lexical decision task. Therefore, the participants were not even aware that they would complete a lexical decision task in the experiment or that the animal cues would be presented as words. Thus, participants in this condition could not create an association between their intention to respond to animals and the ongoing task in which these event-based cues would eventually occur. In the regular-association condition, participants were given the ongoing task instructions with the prospective memory instructions following directly afterwards. This condition resembles previous paradigms typically utilized in the prospective memory literature (e.g., Marsh et al., 2002). In the strong-association condition participants were given the ongoing task instructions with the prospective memory instructions following afterwards as well. Additionally, participants in the strong-association condition were asked to form an implementation intention using visual imagery to imagine themselves responding to animals in the context of making the word–nonword judgments in the ongoing task (Gollwitzer, 1999; McDaniel, Howard, & Butler, 2008). More specifically, for 30 s participants closed their eyes and imagined completing the lexical decision task while repeating the statement "If I see an animal then I will press the slash key after making a word response" (Meeks & Marsh, in press). In all conditions the experimenter reiterated the instructions to the participants and started the next phase after the participants acknowledged that they understood the instructions.

Results and discussion

As can be seen in Figure 1, the stronger the association between the event-based prospective memory cues and the lexical decision task, the greater the number of event-based cues that were detected in that ongoing task. The difference between cue detection in the three conditions was significant, $F(2, 87) = 17.20$,

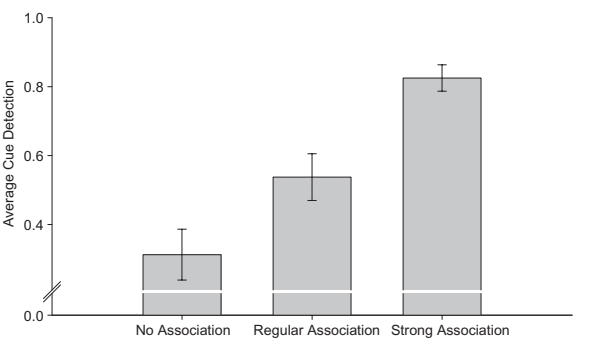

Figure 1. Means and standard error bars representing the proportion of event-based cues detected in three conditions, reflecting the encoded strength of the association between the cues and context in which they were to occur.

$p < .001$, $\eta^2 = .28$. Post-hoc tests indicated that each condition significantly differed from the other conditions, smallest difference $t(58) = 2.24$, $p < .05$. One potential interpretation of this result is that participants in the no-association condition may not have understood the instructions. Nevertheless, at least half of the participants in the no-association condition detected cues indicating that weakened encoding led to their detection failures rather than misunderstanding the instructions. Also, as mentioned previously, all participants indicated to the experimenter that they understood the instructions after reading and having them explained. Therefore, the results from Experiment 1 clearly demonstrate that the association formed at encoding between event-based prospective memory cues and the context in which they will ultimately occur is of great importance for successful cue detection (Marsh, Hicks, & Cook, 2008). Given that the associations formed between the cues and the future context in which they were to occur mattered, we reasoned that people with episodic information about a future context in which an intention could be fulfilled would encode their intention more elaborately (i.e., more cohesive future simulation). The quality of a mnemonic representation directly influences its likelihood of being retrieved (Tulving, 1983). Consequently, in Experiment 2 we provided participants with episodic information about their future context by manipulating the amount of practice that they had with the lexical decision task before they encoded their event-based intention. If participants with practice have more relevant contextual elements available when they encode an intention for the future, then they should successfully complete that intention more often. This prediction was tested in Experiment 2.

EXPERIMENT 2

Method

Participants

Undergraduate students from the University of Georgia volunteered in exchange for partial credit toward a research appreciation requirement. Each participant was tested individually in sessions that lasted approximately 25 min. A total of 70 participants were randomly assigned to one of two between-subjects conditions. The primary between-subjects variable was whether or not participants received practice with the ongoing lexical decision task before forming the intention to respond to words denoting animals.

Materials and procedure

The ongoing task characteristics were similar to Experiment 1 except in the following regards. Participants in the no-practice condition received the intention to respond to animals after being instructed about the lexical decision task whereas the participants in the practice condition completed an initial 40 trials of practice with the lexical decision task before encoding the intention to respond to animals. To equate performance in all regards except intention formation, both groups of participants performed the lexical decision task for 40 trials. At this juncture, the computer paused and a message informed the participants that they were to receive additional instructions from the experimenter. In the no-practice condition, the experimenter merely reminded the participants of their event-based intention and asked them to complete a math task (i.e., multiplying two three-digit numbers) before continuing with a longer sequence of the same judgments. In the practice condition, participants were instructed that we were also interested in whether they could detect animal words during the lexical decision task. After acknowledging that they understood the instructions, the participants in the practice group completed the same math task before continuing the lexical decision task. The time to deliver the no-practice versus event-based instructions in the two different conditions was equated by the experimenter with a handheld stop watch. Participants in both conditions encountered animal words six times over the succeeding 170 lexical decision trials. In all other respects the two conditions were treated identically.

Results and discussion

As can be seen in Figure 2, participants in the practice condition detected more cues than participants in the no-practice condition, $t(68) = 2.72$, $p < .01$, $d = 0.66$. Therefore, having more episodic information about the lexical decision task at the time of encoding allowed participants in the practice condition to form a more elaborate intention. Participants in the no-practice condition were simply reminded about their intention, but this reminding did not result in the same benefit of having experience with the lexical decision task.

GENERAL DISCUSSION

Consistent with research on episodic future simulation, the results from the two experiments presented here provide original evidence that aspects of encoding are

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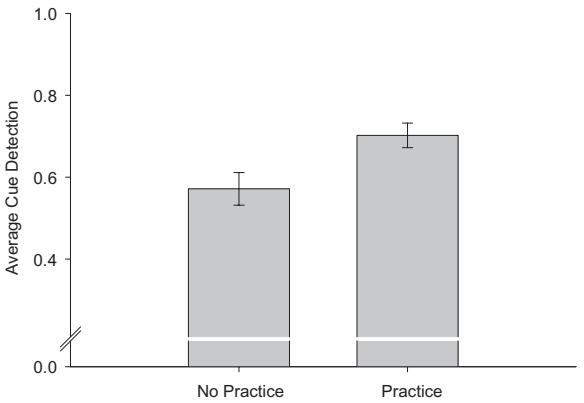

Figure 2. Means and standard error bars representing the proportion of event-based cues detected as a function of the degree of experience participants had with the lexical decision task before forming their intention.

an important factor in event-based prospective memory. In Experiment 1, the strength of the cue-to-context association formed at encoding determined the likelihood that an event-based prospective memory was fulfilled. This result clearly demonstrates that the strength of the cue-to-context association is an important variable in determining event-based cue detection (Atance & O'Neill, 2001). In Experiment 2, participants in the practice condition encoded more information about the future context in which event-based cues were to occur when they formed the intention to make a special response to animal words. *Ceteris paribus*, this episodic information allowed the participants in the practice condition to simulate a more detailed representation of the future and ultimately had the effect of improving cue detection (Okuda et al., 2003; Szpunar & McDermott, 2008). These results speak directly to theories of prospective memory and they are also important for guiding future neuroimaging studies of episodic future simulation as it relates to prospective memory. A primary goal for prospective memory researchers has been to delineate how event-based cues are detected, and further, how behavioral plans that are associated with these cues are retrieved from long-term memory. Several theories have been proposed that address these detection and retrieval processes supporting event-based prospective memory (McDaniel & Einstein, 2000; Smith, 2003). These approaches are informative in describing detection and retrieval processes that operate in prospective memory, but do not explicitly address encoding processes in any specific detail. For example, in the multiprocess theory of event-based prospective memory it is proposed that people rely on multiple cognitive processes to support cue detection and target retrieval (Einstein et al., 2005). One important variable that influences the types of cognitive processes that people rely on is the degree to which ongoing task processing focuses them on the relevant features of event-based cues (Einstein & McDaniel, 2005). More specifically, when processing in the ongoing task highlights features of the cue in a similar manner to when they were processed at encoding, the likelihood that the intention will be fulfilled increases dramatically. Einstein and McDaniel (2005) related this finding to the transfer-appropriate processing literature (Morris, Bransford, & Franks, 1977; Roediger, Gallo, & Geraci, 2002).

The current results extend the notion of transfer-appropriate processing by demonstrating the importance of considering future contexts when encoding event-based prospective memories. That is, when a future context can be simulated at encoding, intentions are more likely to be fulfilled. Theoretically, when there is high degree of overlap between the simulated context at encoding and the retrieval context in which event-based cues are encountered, the intention will be fulfilled more often. This effect is presumably driven by the encoding-specificity principle (Tulving & Thomson, 1973). Thus, both the focus encouraged by ongoing cognitive processing *and* the degree of contextual overlap between the simulated and the actual retrieval contexts will influence event-based prospective memory. Both of these variables underscore the importance of investigating a variety of encoding processes that are used to create prospective memories. Clearly, these results suggest that neuroimaging techniques will be a valuable tool for studying the encoding processes that support forming intentions for the future. Noninvasive neuroimaging techniques have been used, with much success, to investigate the encoding process during *retrospective* memory formation (Wagner et al., 1998). We are arguing here that these subsequent memory designs can further clarify the relation between retrospective and prospective memory as well as helping to specify the encoding conditions that will lead to more efficient intention retrieval.

Building on this idea, we know that episodic memory is a flexible system that allows people to remember past events and simulate future events (Atance & O'Neill, 2001; Buckner & Carroll, 2007; Schacter & Addis, 2007; Tulving, 1983). As such, the reliance on declarative representations for guiding future behavior is an important function of episodic memory (Dudai & Carruthers, 2005; Suddendorf & Corballis, 1997). Previous neuroimaging research has pointed to similar neural regions that support episodic

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memory, future simulation, and encoding intentions for future behavior (Schacter & Addis, 2007; Simons, 2009, Szpunar et al., 2007). Based on the results from the current study, and preliminary neuroimaging data, a critical nexus exists between episodic future simulation and encoding prospective memories. This hypothesis is supported by the present behavioral results but remains to be tested with functional neuroimaging techniques. Functional imaging researchers can capitalize on the current findings by having participants complete multiple encoding–retrieval runs in an fMRI environment. For example, participants could encode faces (e.g., event-based cues) and plan to make special (e.g., target) responses to those faces later in the context of an unrelated ongoing task. In the ongoing task participants would encounter the faces and make their special responses before moving on to the next encoding phase. Furthermore, the degree of association between the faces and the ongoing task could be manipulated to assess the neural underpinnings of association in prospective memory. Analogous to the subsequent memory designs described earlier, this approach would elucidate the encoding and retrieval conditions that engender successful fulfillment of intentions as well as identifying the neural regions that support encoding of prospective memories. A similar approach has been successfully applied in the fMRI environment and it has been suggested that patterns of activation in the medial prefrontal cortex can be decoded to determine which of two intentions participants were currently maintaining (Haynes et al., 2007). As discussed previously, similar brain regions have also been implicated in memory for contextual information as prospective memory (i.e., source memory; Johnson, Hashtroudi, & Lindsay, 1993; Mitchell & Johnson, 2009; Simons, 2009).

According to the source monitoring literature, people monitor the source of their memories by capitalizing on average differences in episodic features that are associated with different types of experience (Lindsay, 2008). This approach to remembering is both constructive and feature-based, which is in line with the episodic simulation research described previously (Mitchell & Johnson, 2000). According to our view, prospective memories consist of varying levels of different episodic features including the encoding context, the prospective retrieval context, the potential event-based cues, and the behavioral plan that needs to be fulfilled. The results from the current study indicate that manipulation of the episodic features available at encoding has direct consequences on the fulfillment of event-based prospective memory. Recent evidence for a neuropsychological nexus between source memory and prospective memory has come from Burgess, Shallice, Gilbert, Simons, and colleagues (e.g., Simons, Schölvinck, Gilbert, Frith, & Burgess, 2006). For example, when participants link their event-based intention to a specific future context, their likelihood of fulfilling that intention increases dramatically (Marsh et al., 2008). Thus, contextual information and association are important determinants of successfully fulfilling intentions.

Together, these research traditions have made substantial progress on explaining and predicting the detection of event-based prospective memory cues. However, a more general theory of intention retrieval from long-term memory will become necessary to account for encoding and retrieval interactions, attentional shifts over time, metacognitive strategies, and the successful use of context as a marker for engagement of cue-focused processes (Einstein & McDaniel, 2008). Also, given that different types of intentions (e.g., event-, time-, and activity-based prospective memories) will have considerable overlap in terms of their retrospective components and general mnemonic features, a more general theory of prospective memory could be developed to account for encoding and retrieval of these ostensibly disparate types of intentions. One route toward theorizing on this topic would be to appeal to Johnson et al.'s (1993) source monitoring framework (Marsh et al., 2006). When encoding different types of intentions, people may use different memorial attributes, or qualitative characteristics, depending on the nature of that intention (Bower, 1967; Underwood, 1969). In more ecological settings people probably encode intentions consisting of multiple characteristics rather than relying on only perceptual, conceptual, or temporal cues like those intentions formed in most laboratory investigations.

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ORIGINAL RESEARCH

Localizing sadness activation within the subgenual cingulate in individuals: a novel functional MRI paradigm for detecting individual differences in the neural circuitry underlying depression

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Abstract Variations in frontal lobe (FL) functional anatomy, especially the subgenual cingulate gyrus (SGC) suggest that mapping on an individual rather than group level may give greater insight regarding dysregulation of the neural circuitry involved in depression, as well as potentially provide more specific or individualized treatment plans for depressed patients. We designed a functional MRI task capable of imaging FL activity in individuals, including the SGC region, using a transient sadness paradigm. We sought to develop a method that may better detect individual differences of FL subregions related to sadness, since this region has been implicated to show dysregulation in depression. The task was based on a block design that also accommodates individual differences in responsivity to a sadness induction paradigm. Individual differences from nine non-depressed healthy volunteers were analyzed. We also performed functional connectivity analyses to further characterize our findings to the networks associated with the SGC in each individual. The study was designed to account for individual variation rather than using a true experimental design; therefore, no control group was necessary. As expected, due to inter-individual variability, the specific site of SGC activation during sadness varied across individuals. Activation was also observed in other brain regions consistent with other studies of induced sadness and depression. Patterns of functional connectivity to the SGC also highlighted neural circuits known to subserve sadness and depression. This task promises to more precisely localize a given individual's functional organization of the brain circuitry underlying sadness, and potentially depression, in an efficient, standardized way. This task could potentially aid in providing individualized targets in the treatment of depression.

Keywords Depression · Functional MRI · Frontal lobe · Sadness induction · Subgenual cingulate

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Introduction

Depression affects an estimated 121 million people worldwide and ranks among the leading causes of disability (World Health Organization, http://www.who.int/mentalhealth/management/depression/definition/en/index.html).

Although many patients with major depression respond to medication and/or psychotherapy, at least 20% of patients do not respond to these or other treatments, such as electroconvulsive therapy, and are considered to have treatment-resistant depression (TRD). For these patients, many novel therapies are under investigation, including

vagus nerve stimulation (FDA approved for TRD 2005), repetitive transcranial magnetic stimulation (FDA approved for depression 2008), and deep brain stimulation (DBS) to targeted brain regions (Mayberg 2009).

Recently, the successful use of DBS for treating movement disorders by direct neuromodulation has sparked an interest in the subgenual cingulate gyrus's role in depression (Hamani et al. 2009; Mayberg et al. 2005). Positron emission tomography (PET) studies have described dysregulation of a corticolimbic neural circuit that includes frontal and subcortical structures and highlighted the subgenual region of the anterior cingulate (SGC) as a critical region underlying depression (Mayberg et al. 1999, 2005). Mayberg's findings show SGC functional overactivation in depressed patients and resolution of this hypermetabolism in those patients who show symptom remission after disruption of function in this area due to DBS. This finding of normalized SGC function also occurs in patients successfully treated with antidepressants (Drevets et al. 2002; Goldapple et al. 2004; Kennedy and Giacobbe 2007; Mayberg et al. 1999, 2000). Hamani et al. recently reported that, while a significant percentage of the patients in the DBS series responded favorably, about 45% failed to respond (Hamani et al. 2009). Since the surgical targeting strategies used for DBS in depression are standardized, it is possible that variability in functional brain organization in the subgenual cingulate region (Vogt et al. 2005) may lead to lack of individual specificity in electrode placement. Indeed, it has been established that there are individual differences in the precise location of language and other cognitive functions (Bookheimer 2007; Ojemann 2003) and fMRI is routinely used to map the precise location of language, motor, and other functions to assist with surgical resection of brain lesions. Because the downstream cortical and subcortical targets of the cingulate cortex vary depending on the precise region selected for stimulation, the therapeutic effects of DBS might depend on proper subject-specific electrode placement (Johansen-Berg et al. 2008). Given the relatively poor spatial resolution obtained by PET studies, the exact location(s) within the general SGC region showing abnormal activation in depressed patients has eluded further characterization.

Functional MRI (fMRI) is widely used in the presurgical mapping of language, motor and other behavioral functions across a variety of disorders because of its good spatial resolution (Bookheimer 2007). Therefore, it may prove helpful in distinguishing individual differences in SGC functionality and providing a useful method in assessing treatment efficacy and for neuronavigational purposes. Previous fMRI studies describe a network of midline frontal, subcortical, and limbic regions in paradigms designed to address depression (Gotlib et al. 2005; Hamilton et al. 2010), however, few consistently show the SGC activity that Mayberg reported using PET (Chen et al. 2007; Gotlib et al. 2005; Keedwell et al. 2009; Siegle et al. 2006). There are factors associated with individual differences on both neuroanatomical and behavioral levels that may account for the difficulty imaging SGC activity. Almost all studies examine fMRI activation patterns on a group level, thereby potentially missing subgenual activation that shows functional neuroanatomical variations among individuals. On a behavioral level, it is likely that there are mismatches in the model design and reactivity to emotional stimuli because of individual differences in shifting between emotional states.

The aim of this study was to design an fMRI task capable of visualizing frontal lobe activation at an individual level using a sadness induction paradigm that overcomes some of the difficulties encountered in studying emotion induction using fMRI, which generally relies on a time-dependent response to the presented stimuli. This task was designed to parallel the PET studies, and in doing so we sought to provide higher spatial resolution imaging in order to further characterize the circuitry involved in sadness within individuals, focusing on the SGC and its connections to other regions relevant to sadness and depression. We set out to design and test a task in healthy subjects that provides data for regions including the SGC on an individual level, which would functionally define the hypothesized dysregulated area in order to better characterize this region for studies of depression and treatment planning.

Materials and methods

Participants

The task developed was tested in 9 healthy participants: 5 right handed (3 F/2 M) and 4 left-handed (2 M/2 F) volunteers ages twenty-four to fifty who were recruited from the local community. All participants were screened to exclude any cognitive or health problems, including neurological, psychiatric, and other medical problems. None were taking any psychiatric or other medications or had any history of psychiatric disorders, including depression. All participants provided written consent which was approved by the hospital's Institutional Review Board.

Task development

This task was designed to compare a sad state to a neutral one, as is typical in a block design study. However, we recognized that the time to achieve a sad state in individuals is likely to vary; therefore, the on-off block design paradigm was altered to account for differences in individual responsivity to sad

stimuli. We developed a "hybrid" block design task that can ultimately be of variable length among individuals but from which standardized blocks of sad and baseline conditions can be obtained. To make the task flexible, we designed an Adobe Flash program that presents the appropriately valenced stimuli continuously until the participant signals through a button press that they have achieved the desired emotional state. The button press signals the program to begin a standardized 30 s block from the same emotional set of stimuli. Each task utilizes a combination of emotionally congruent visual and auditory stimuli. For example, the "sadness" task shows a series of sad pictures accompanied by mournful music until the participant presses the button thereby beginning the first 30 s block of sad stimuli. Once this block is completed, the stimuli change to neutral pictures and music until the participant triggers through button press that their mood has changed to a neutral state and the second 30 s block begins. This alternates for 3 blocks of sad and 4 blocks of neutral conditions (Fig. 1). Neutral stimuli were chosen as contrast as opposed to another emotional condition such as happy stimuli due to the fact that it is unreasonable to expect the subjects to oscillate between such widely opposing emotional states multiple times within such a limited time frame. Additionally, many of the areas underlying emotion within the brain have been shown to increase in activity in response to a wide range of emotional states (Murphy et al. 2003). In order to distinguish the emotional aspects of sadness induction from heightened general arousal that is also subserved by the cingulate (Posner et al. 2009), we included another task that compares engaging pictures and mood-matched upbeat music to the same neutral condition used in the sadness induction task. Each condition within the given task consists of a continuous, pseudo-randomly presented set of state-matched pictures shown for 6 s each. Each picture was allowed to be shown twice within a single run of the task. Within each standardized block, 5 pictures are shown for a total of 30 s. Only the standardized blocks were analyzed in the post-processing steps. Color pictures were used for all conditions. For the sad condition, pictures were photographs depicting death and mourning, mostly individuals crying over the bodies of deceased children or relatives. Engaging pictures were of people interacting in social settings. Neutral pictures were landscapes. An average of 65 photographs were shown per condition. In order to increase the task's capacity to elicit a sad mood, an effect that scanned across each image was introduced to made them appear more movie-like. Music was mournful Celtic music, or neutral or upbeat jazz, depending on the condition. Two runs of each of the sad and engaging tasks were performed in counter-balanced fashion. After completing the study, all participants were asked whether they achieved a sad or other emotional state, and, if so, to indicate whether they became "mildly," "moderately," or "significantly" sad.

Imaging parameters

All participants were scanned on the same 3.0 Tesla GE Signa HDX system with an 8-channel head coil. Scan parameters for gradient echo echo-planar imaging (EPI) are as follows: TR=3000 ms, TE=25 ms, flip angle=80°, FOV

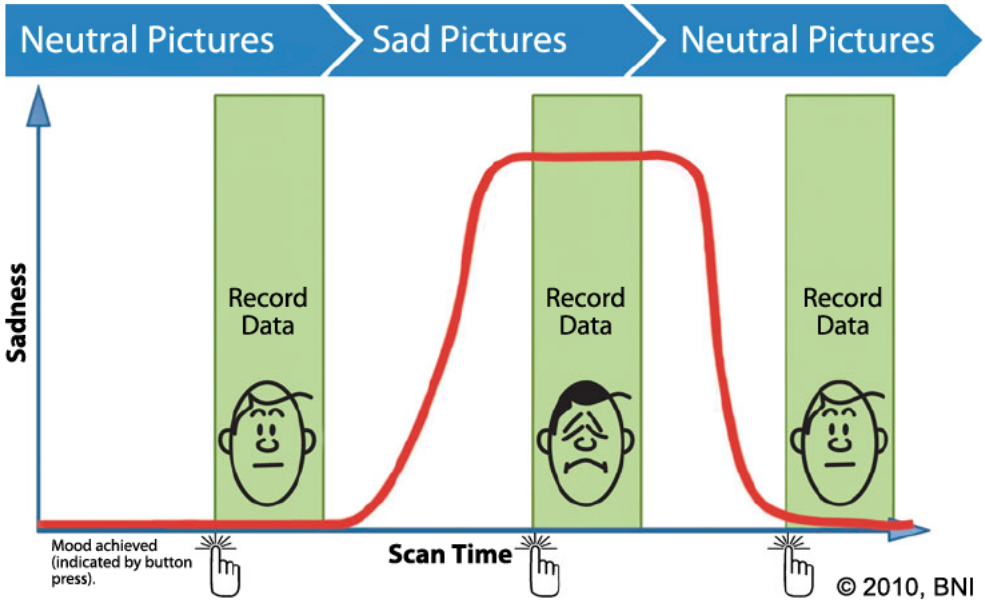

Fig. 1 Illustration of the task design that is flexible to accom modate for individual variability in the time necessary to achieve sadness induction. Stimuli are presented until participant indi cates by button press that they have achieved the target mood state, at which time a 30 s standardized block of the same stimuli is presented. Following this, a set of new stimuli are presented until the participant indicates by button press that the new target mood state has been achieved, which subsequently initiates a standardized 30 s block of sad stimuli. Data anal ysis is performed on 4 neutral and 3 sad blocks that are obtained per run. *Used with permission from Barrow Neurological Institute*

24 mm, in-plane resolution 64×64, with 4-mm-thick slices covering the entire brain. A high resolution structural 3-D T1 sagittal image was also obtained for each participant: TR=minimum, TE=2.5 ms, flip angle=8°, FOV=26 cm, 256×256 matrix, 1.2 mm thick slices.

Statistical analyses

All analyses were performed using statistical parametric mapping (SPM5, http://www.fil.ion.ucl.ac.uk/spm) implemented in MATLAB 7.1 (MathWorks Inc., Natick, MA, USA). For each individual, only the 30" blocks of data occurring after the button presses (e.g., a steady-state mood condition) were analyzed. In order to determine individualistic activation patterns, all data were analyzed in native space. Volumes were realigned and coregistered to each individual's T1 image. A minimal Gaussian kernel of 2-mm isotropic full-width at half-maximum (FWHM) was used for smoothing in order to maintain good spatial resolution within the SGC. The conditions were modeled with a canonical hemodynamic response function (HRF) and a high pass temporal filter of 150 s. The focus of our study was the anterior frontal lobe region; therefore, we performed both region of interest (ROI) as well as whole-brain analyses for each individual. We generated a priori customized explicit masks of the frontal lobe from the T1 image using MRIcro software (http://www.mricro.com) to isolate an ROI including Brodmann areas 24, 25, 32, and 33 in total, as well as the posterior, medial portions of Brodmann areas 10, 11, and 12. Contrasts were set to test for voxel-wise signal differences between sad versus neutral conditions and engaging versus neutral conditions for the respective tasks. Statistical parametric t-maps were calculated for each individual subject. The contrast maps from the engaging versus neutral condition ($p \leq .05$, voxel extent threshold=10) were used to explicitly mask the analysis of the sad versus neutral condition. This was performed to control for any activation due mainly to a change in general arousal, especially in the cingulate, and thereby isolate activation due to the sad state. Because we had particular interest in finding individual differences in SGC activation during sadness induction, isolated from widespread general arousal, as well as in finding a seed region that could be used for functional connectivity analyses, we selected a priori a liberal threshold for each individual's data of $p=0.05$, with a cluster extent of at least 20 contiguous voxels meeting that threshold. While this threshold is somewhat liberal, it is reasonable both when compared to other clinical uses of fMRI as well as when considering the very limited size of the SGC region. We also performed parallel group analyses by normalizing each participant's data to the MNI template and smoothing to 6 mm^3. Sad vs. neutral and engaging vs. neutral contrasts were then entered into a one-way analysis to examine common group activations, at a threshold $p=.01$ and extent threshold of 150 contiguous voxels.

Functional connectivity analysis

To increase the validity of our SGC findings and ensure this task provided an accurate reflection of the neurocircuitry involved in depression, we also performed functional connectivity analyses. This provides further support that modeling the region of increased activation during the sad vs. neutral comparisons reflects activation of other regions that have been found to be active during sadness induction in the literature. Since the SGC was the main point of interest for the present study, it was used to determine what other cortical regions show a temporal correlation with this region. The targeted regions (circled regions in Fig. 2) based on the voxels with the highest z-scores within the SGC were selected for each participant to extract BOLD response time series values to define the regional voxels of interest (VOI). Each VOI's limit was defined as a 1 mm sphere around these selected voxels; a small seeding region was chosen because of the proximity of the SGC to the brain's midline. The VOI was then used in a functional connectivity analysis implemented in SPM5 for each participant, which deconvolved the HRF from the fMRI signal to yield each individual's neuronal time series for the sadness vs neutral conditions. This task variable was then multiplied by the deconvolved neural signal and convolved with the HRF at each scan. This yielded three separate time series vectors: the convolved task multiplied by the neuronal signal, the original eigenvariate to be used as a covariate of no interest, and the model convolved with the HRF. Each vector was then entered as a separate regressor into a general linear model (GLM) and analyzed using SPM5. We chose a liberal threshold of $p=.01$, 10 voxel extent to ensure that each individual's SGC activation co-occurs with the activation in other areas consistent with sadness induction, since a higher threshold would restrict our ability to determine if this activation was instead reflecting a response independent of our design.

Results

Sadness induction in participants

All participants reported that they were moderately to significantly sad during both runs of the sad task (7 of 9 indicated "moderately sad," while 2 of 9 indicated "significantly sad"). None reported feeling anxiety, anger,

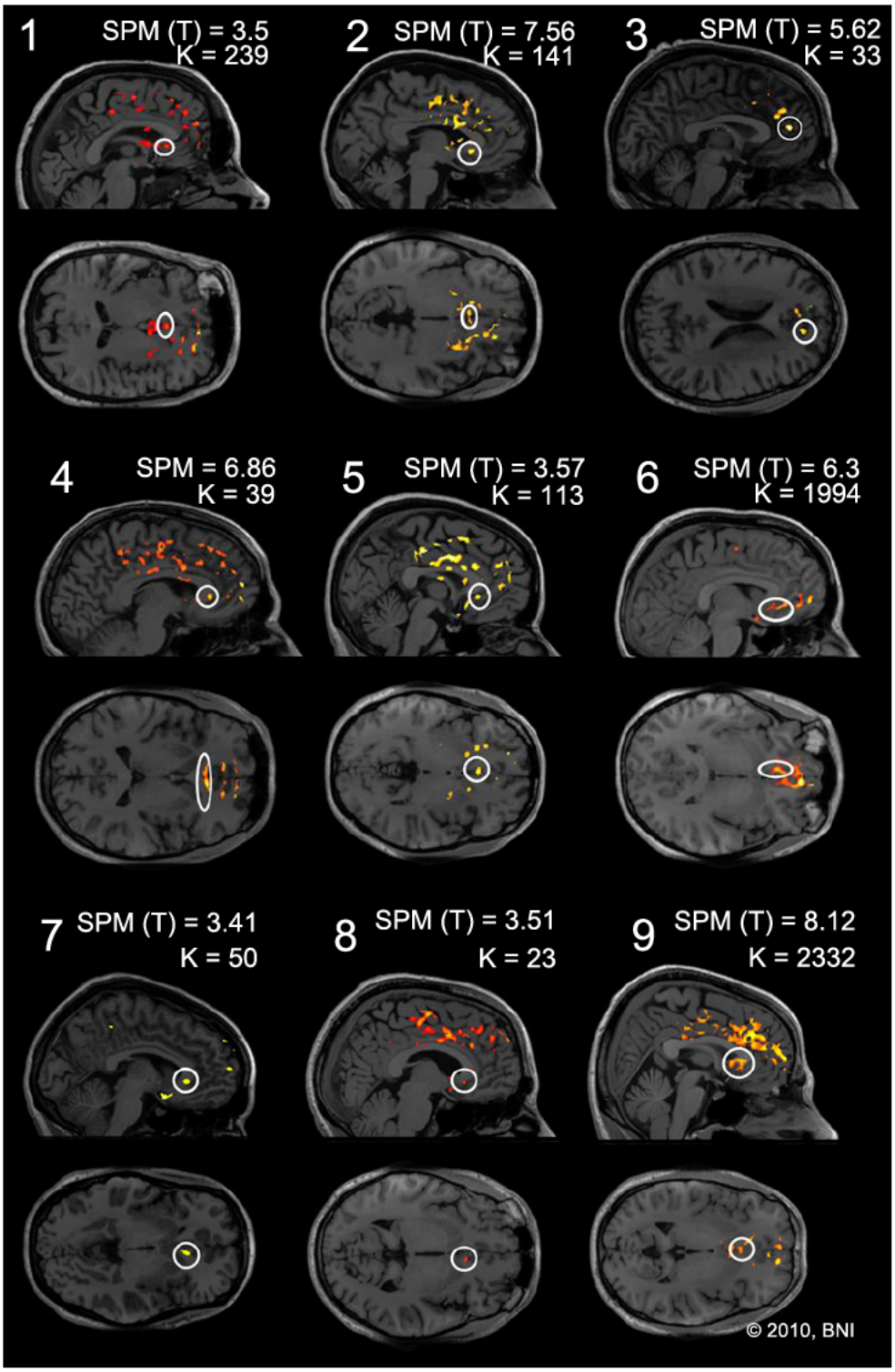

Fig. 2 Sagittal and axial sections from 9 healthy individuals showing fMRI activation during a state of induced transient sadness. ROI mask included Brodmann areas 24, 25, 32, and 33 in total, as well as the posterior, medial portions of Brodmann areas 10, 11, and 12. Circled is the activation cluster (in or near the SGC region of each individual) which was selected as the seeding point in the PPI analyses performed; the SPM(T) value and the number of contiguous voxels reaching that threshold (k) for the selected region are also provided. Most subjects also showed significant activity in the anterior and mid cingulate, as well as the medial prefrontal cortex during sadness induction. *Used with permission from Barrow Neurological Institute*

disgust, or any other emotion during this condition. All experienced the engaging task as "upbeat," or "interesting", and reported that the neutral condition was "soothing", "calming" or "relaxing". As expected, there was variation in the time it took for each individual to achieve a given state, which created a difference in the start time of the standardized blocks. The mean time to achieve a sad state is presented for each individual in Table 1 and was as short as 2 sad pictures (i.e., 12 s) to as long as 9 pictures (54 s). The total scan times from each of the 4 runs (2 sad, 2 engaging) ranged from about 5 to 10 min per task. Most individuals were fairly consistent between

Table 1 Participant demographics and fMRI results

Subject Number	Gender (M/F), Age (years), Handedness	Scan Time (seconds),	Mean number of images needed to induce sadness
1	F, 50, R	Sad #1: 297 Sad #2: 351	Images: 2
2	F, 32, L	Sad #1: 528 Sad #2: 414	Images: 6
3	M, 26, L	Sad #1: 498 Sad #2: 372	Images: 9
4	F, 25, R	Sad #1: 432 Sad #2: 387	Images: 5
5	M, 31, L	Sad #1: 456 Sad #2: 468	Images: 7
6	F, 25, L	Sad #1: 273 Sad #2: 303	Images: 2
7	F, 23, R	Sad #1: 393 Sad #2: 375	Images: 4
8	M, 28, R	Sad #1: 510 Sad #2: 339	Images: 5
9	M, 29, R	Sad #1: 423 Sad #2: 417	Images: 6

runs. There was no evidence of habituation during or across task runs (e.g., a given participant did not take longer to indicate sadness as the task progressed or on the subsequent run).

Activation patterns in each individual

The contrasts depicting the frontal lobe activation patterns for the sad condition masked by the engaging condition for all subjects are presented in Fig. 2; each panel represents data from an individual superimposed on their own anatomic scan. The SPM(T) values and extent sizes for a cluster in the SGC region are circled, indicating that 8 of 9 participants showed activation in the SGC. One person showed pregenual cingulate rather than SGC activity during transient sadness. All participants also showed suprathreshold activity in other frontal regions, including anterior and midcingulate as well as ventromedial prefrontal lobe regions. Whole-brain analyses in the engaging condition for all of the individual contrasts revealed activation in all but one subject within the cingulate gyrus, including the SGC, albeit in different positions than the activation peak for the sad masked by the engaging condition (data not shown).

Group activation patterns

Random-effects analyses were also performed on contrasts for the sad condition, the engaging condition, and the sad condition masked by the engaging condition (Fig. 3). The sad task, when distinguished from general arousal (Fig. 3a), elicited group-level activity in the dorsal anterior cingulate, as well as in the pregenual and subgenual regions, although the locus of group activation in these regions varied from the individual contrasts. The overlaid unmasked sad and engaging contrasts (Fig. 3b) show overlap in the anterior cingulate cortex including the SGC as well as other midline structures including posterior cingulate as well as the caudate.

Connectivity

The seeds, or region of interest, for the functional connectivity analyses for each participant were the regions highlighted with circles in Fig. 2. We observed some consistency in functional connectivity patterns across participants (Fig. 4). Most participants (8/9) showed connectivity with regions in the posterior and midcingulate as well as medial PFC regions. About half (4/9) showed connectivity in the frontal pole. Over half (5/9) also showed connectivity with the cerebellum, thalamus, insula and occipital lobe. A third (3/9) showed connectivity in the caudate region and the amygdala.

Discussion

This task was designed as a way to study induced transient sadness using fMRI to better characterize the neural correlates of depression. We attempted to avoid some of

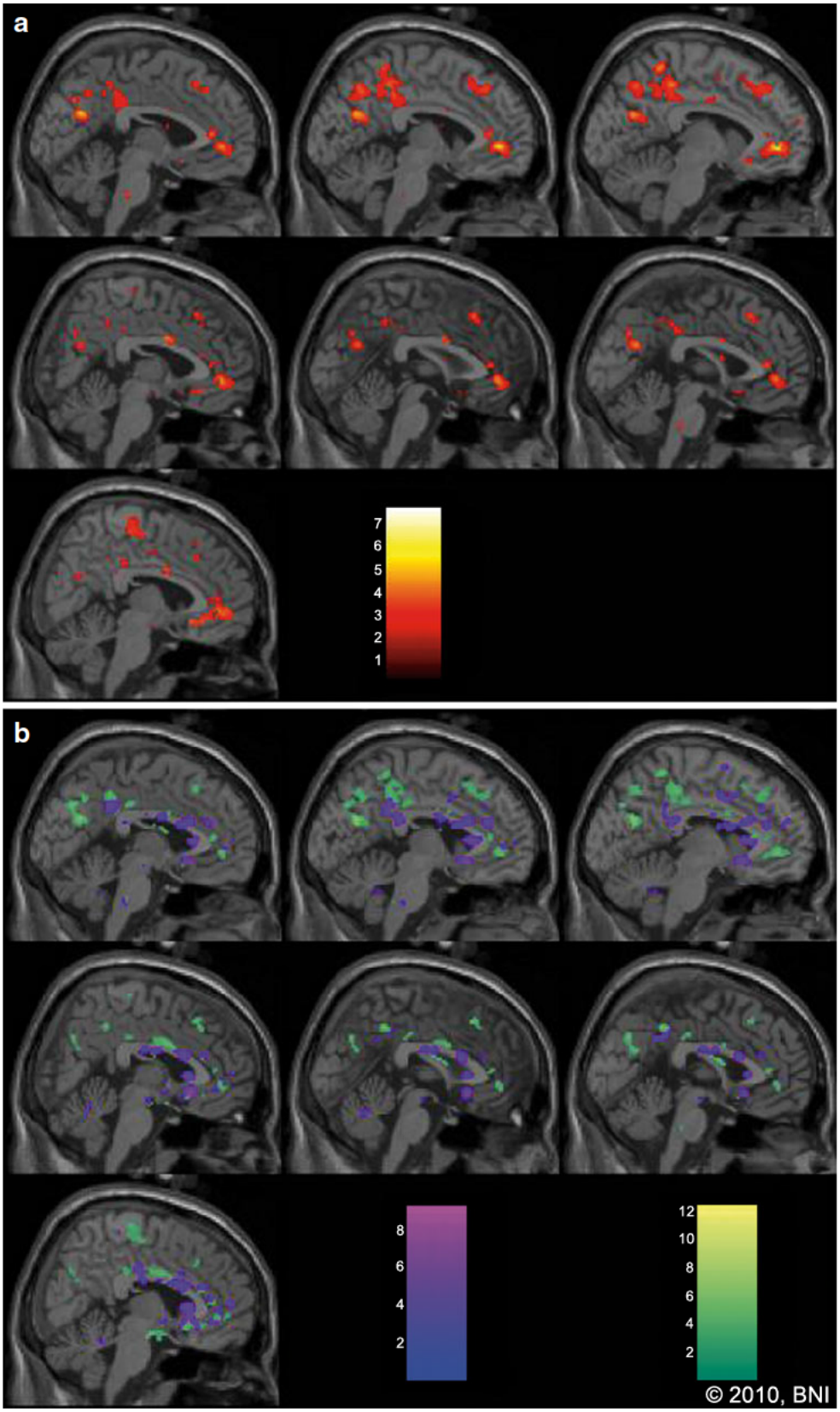

Fig. 3 Group (*random effects*) brain activation overlaid on MNI template (*sagittal sec tions*), from the sad contrast masked by the engaging contrast (3a) and the sad (*green*) and engaging (*purple*) conditions overlaid onto the MNI template (3b). *Used with permission from Barrow Neurological Institute*

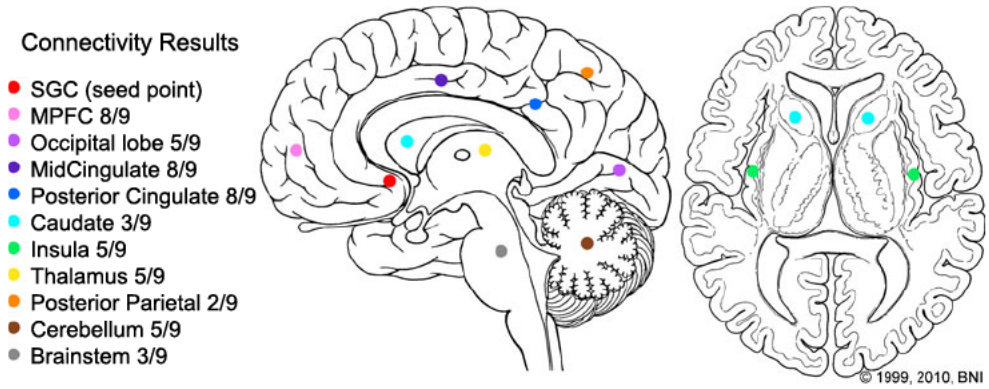

Fig. 4 Summary of functional connectivity analyses in individual participants. SGC seeds from the individuals varied and are listed in Fig. 2. The number of subjects who showed connections to each region is listed to the left of the illustration. *Used with permission from Barrow Neurological Institute*

the limitations typically present when investigating correlates of emotional states using fMRI. We assumed that a block design paradigm would be better suited for sadness induction rather than an event-related task because of the difficulty in rapidly shifting between sad and neutral states that would be necessary if stimuli were presented as events, but we determined that people's variability in achieving sadness required flexibility of data acquisition. The flexible task presentation accommodated individual differences in sadness induction by allowing the subject to signal when they reached a target state, at which time a standardized image block can be collected. Variability in sadness induction was observed although successful induction was achieved within 54 s by all subjects from this healthy group. Our euthymic volunteers showed similar rates of acquiring sadness, positive/engaging, and neutral conditions. Depressed patients may show greater variability in induction times and shifting emotional states; we anticipate that they will be able to successfully modulate their emotional state sufficiently to perform the task based on previous PET studies of sadness induction (Liotti et al. 2002). A future study including depressed patients is planned to address this issue and determine whether different phenotypes of depression may show regional differences in activation patterns and strength of connectivity. Individual differences in sensitivity to emotional stimuli were also minimized by selecting pictures and music relating to death and mourning, which successfully induced a sad state in all participants. Thus, this task is designed such that it both flexibly allows for individual differences, but is also more standardized and efficient than other methods commonly used such as autobiographical recall or film clips.

We also thought it important to distinguish sadness induction from activation related to a general increase in arousal from the neutral baseline state (Posner et al. 2009). We accounted for increased arousal by subtracting those voxels activated by an "engaging" task, consisting of pictures of people but in neutral social situations, from the activation obtained during sadness induction. Both tasks showed common anterior cingulate/frontal lobe regions, suggesting that these regions are activated in arousal across a range of affective dimensions, but regions in the SGC and frontal lobe remained during sadness induction even when we controlled for our measure of more general arousal (see Figs. 2, 3 and 4). Interestingly, activation due to arousal was found even in the SGC, which contrasts the assumption that it is relegated to the rostral anterior cingulate cortex and suggests that accounting for general arousal may be important in depression studies.

Activation patterns in nearly all participants included the SGC region for the sad masked by the engaging condition, although one participant's activity was located in the pregenual rather than subgenual region. There was no obvious reason for the pregenual activation observed in that participant, such as a lack of objective sadness, but that individual took longer than others to attain a sad state (Table 1). As we hypothesized, the SGC activity did not necessarily overlap across participants (see Figs. 2 and 3), which is consistent with the notion that individual neuroanatomical differences exist in this region. SGC activation was observed in the group data with some but not complete overlap with the individual findings, which is as expected given the region's variability on an individual level.

We highlighted SGC activity during this task because many studies have focused on this region in relation to treating patients with treatment-resistant depression (Drevets et al. 2002; Goldapple et al. 2004; Kennedy and Giacobbe 2007; Mayberg et al. 1999, 2000, 2005), predicting treatment responsiveness in medication (Mayberg 2003) and CBT (Siegle et al. 2006) trials, as well as its pivotal role in the emotional processing of negative stimuli (Gotlib et al. 2005; Siegle et al. 2006). While a few studies initially found decreases in SGC metabolism (Drevets et al. 1997; 1998), the most well-replicated result to date is an increased glucose metabolism associated with major depressive disorder (Inagaki et al. 2007; Kumano et al. 2007; Mah et al. 2007). However, other regions within the depression circuitry were also consistently activated across subjects, including bilateral ventrolateral prefrontal, orbitofrontal and

midcingulate cortex as well as insula, amygdala, thalamus and cerebellum (Table 1). A recent study using resting-state fMRI showed disruptions in the prefrontal-limbic circuitry with decreased connectivity even greater in groups of treatment resistant depressives compared to a group of well-controlled patients (Lui et al. 2011). Our future studies will investigate whether individual differences in the connectivity between all of these important regions implicated in depression might also influence response to treatment.

Since we showed some variation in the location of activity within the SGC region, we also chose this subject-specific site to perform functional connectivity analyses to demonstrate that the activity in SGC was part of a network of regions that have been implicated in studies of sadness and depression. Our findings show, on an individual level, that the induced state of sadness obtained during this task engages a network including the SGC along with regions of the frontal lobe, especially the medial prefrontal cortex, which is consistent with other group studies of connectivity during sadness and depression. A recent study found that contributions from the SGC to the default mode network (encompassing prefrontal and cingulate cortices) of resting brain function are substantially increased during depression compared to a healthy state (Greicius et al. 2007). Furthermore, the increased activity of the subgenual cingulate during depression has been found to predict the subsequent decrease in activity in the posterior cingulate cortex, dorsomedial prefrontal cortex, and ventral striatum in depressed patients more so than in healthy controls, indicating increased connectivity (Hamilton et al. 2010). Aside from the SGC, findings of consistent activation of portions of the medial prefrontal cortex (BA 10), the rostral anterior cingulate (BA 24), and midcingulate during sadness induction are in line with a recent tractography study (Johansen-Berg et al. 2008). Johansen-Berg et al. showed evidence of two distinct, but overlapping, white matter pathways connected with the anterior cingulate region. Others have suggested there are two underlying pathways subserving sadness, one more dorsal pathway relating to cognitive components of depression, and a ventral pathway (including subcortical regions) reflecting the emotional components of depression (Mayberg et al. 1999). Activation patterns obtained in the present study are most consistent with the overlapping regions demonstrated by both Johansen-Berg et al. and Mayberg et al. and therefore our task does not clearly distinguish between the cognitive and emotional circuitry underlying sadness, which again may reflect individual differences in processing of emotional stimuli.

There are only a few studies examining transient sadness using fMRI. Beauregard et al. used film clips and neutral baseline blocks in a small group of depressed patients (Beauregard et al. 1998). The degree of sadness achieved during the task was retrospectively assessed (0 to 8 Likert scale) after the task was completed, with sadness varying from 0 (no sadness) to 8 among the depressed patients and 1–7 in the normal controls, suggesting much variability in the ability of this task to generate sadness. This may be due to the limitations of using a standardized (2.5 min) block of induction stimuli. Only group comparisons were made, showing increased activation in bilateral frontal regions, cingulate and caudate, among others, and midcingulate and frontal regions showed greater activation in the depressed patients compared to controls. Another study by Eugene et al. also used sad film clips to elicit sadness, but the blocks in this case were just 48 s long (Eugene et al. 2003). On average participants achieved an emotional reaction, but the analysis was done in a typical block design manner. It is possible that the individual differences in reactivity to sad stimuli blurred the signal obtained within the blocks across the 20 subjects in this study. In other words, although all the participants acknowledged that they were sad during the film clips, it was not possible from the data collected to adjust for individual differences in the timing of sadness induction. Goldin et al. addressed the limitation of successfully capturing sadness induction activation using a task that most closely matches our task. Film clips were used to induce both sadness and amusement that were presented in counterbalanced standard blocks 2 min long (Goldin et al. 2005). They used retrospective ratings by the participants and determined that similar activation patterns could be modeled by both as a standardized block contrast and by subject-specific ratings of sadness, and they suggested that sadness induction is characterized by a "steady-state, nonfluctuating profile." Similar to our findings, sadness induction was related to activation in the medial PFC and other frontal, temporal, occipital and parietal regions, and the amygdala, thalamus and cerebellum. They did not report activity in the SGC region, however. Others have shown that the processing of negatively- and positively-valenced emotional stimuli can be mapped to particular regions of the SGC (Gotlib et al. 2005). Although our task was different because our focus was not on the processing of emotional stimuli but rather on the phenomenal experience of sad emotion, we did find that the SGC was functionally segregated in that accounting for arousal still resulted in regions unique to sadness induction.

Because we hypothesized that functional anatomical variations in the subgenual cingulate may exist, our methods differed from other fMRI studies in several ways. Most notably, we were interested in maintaining each participant's native anatomical space and therefore did not normalize data to standardized coordinates. For similar reasons, we applied a minimal Gaussian smoothing kernel to minimize blurring of activation "blobs". While there are some drawbacks to these choices, the strengths include the

ability to distinguish possible variations in activation across individuals. Similarly, since we were not attempting to look for common regional activation, we may have increased our ability to visualize SGC activation. We have listed the peak activation levels, along with cluster size, for those regions considered to be consistent with the SGC, and all meet reasonable levels of activity that others have found in group studies of sadness. The fact that our own group analysis revealed a somewhat different activation profile from that of the individuals' data highlights the need for attention to individual differences in studies of depression. Improvements on some of the limitations of the study are planned, such as including more standardized assessment of the level of sadness attained during the task. One limitation of this study was the lack of a more sensitive and standardized method of assessing the levels of sadness achieved. While a Likert scale was not used to assess levels of sadness induction in this study, participants were asked to indicate if they achieved a sad state, and whether this state was mild, moderate, or significant in magnitude. Future studies will incorporate a scale to be done during the fMRI session that could be used to determine whether the strength of the induced emotional state has an effect on the observed activation pattern (Posner et al. 2009).

This task demonstrates individual differences in neural responsivity within the SGC and other medial prefrontal regions that can occur during sadness induction. This approach to paradigm development, which tailors the task to each individual's emotional reactivity, may provide a useful tool in future studies. Such studies may address questions of whether treatments for depression could be tailored on an individual basis, and responder rates increased, by mapping neural activity within individuals that correlates with their sad state.

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Volume II, Cost Proposal

(1) BAA number:	DARPA-BAA-12-03
(2) Technical area:	Technical Area 1 – Narrative Analysis Technical Area 2 – Narrative Neurobiology
(3) Lead Organization submitting proposal:	Arizona Board of Regents on behalf of Arizona State University
(4) Type of business:	Other educational
(5) Contractor's reference number:	12040772
(6) Other team members and type of business for each:	St. Joseph's Hospital and Medical Center, Other Nonprofit
(7) Proposal title:	Toward Narrative Disruptors and Inductors: Mapping the Narrative Comprehension Network and its Persuasive Effects
(8) Technical point of contact to include:	Dr. Steven Corman [redacted]
(9) Administrative point of contact to include:	Ms. Avery Wright [redacted]
(10) Award instrument requested:	Cost-Contract – No Fee
(11) Place(s) and period(s) of performance;	[redacted] 4/1/2012-9/30/2016
(12) Total proposed cost separated by basic award and option(s) (if any);	Basic award cost (Phase 1 and 2) $4,138,258 Option Phase 3 $1,943,364
(13) Name, address, and telephone number of the proposer's cognizant Defense Contract Management Agency (DCMA) administration office:	[redacted]

	[redacted]
(14) Name, address, and telephone number of the proposer's cognizant Defense Contract Audit Agency (DCAA) audit office:	[redacted]
(15) Date proposal was prepared:	10/7/2011 – 11/22/2011
(16) DUNS number:	943360412
(17) TIN number:	86-01-96696
(18) Cage Code:	4B293
(19) Subcontractor Information:	St. Joseph's Hospital and Medical Center [redacted]
(20) Proposal validity period:	4/1/2012 – 9/30/2016

Phase 1

Arizona State University

	1.1	1.2	1.3	1.4	1.5	1.6	1.7	Total
Direct Labor - Hrs	2,275	9,669	4,223	2,462	7,137	3,120	0	28,886
Direct Labor - Costs	$83,980	$234,729	$112,970	$91,748	$201,396	$101,430	$0	$826,253
Fringe Benefits	$32,884	$40,799	$32,750	$32,114	$59,148	$45,801	$0	$243,496
Total Labor Overhead	$61,354	$144,652	$76,503	$65,028	$136,785	$77,296	$0	$561,618
Consultants	$0	$120,000	$0	$0	$0	$0	$0	$120,000
Consultants Overhead	$0	$63,000	$0	$0	$0	$0	$0	$63,000
Equipment	$53,120	$0	$0	$0	$0	$0	$0	$53,120
Materials	$49,262	$0	$0	$0	$0	$0	$0	$49,262
Materials Overhead	$25,863	$0	$0	$0	$0	$0	$0	$25,863
Travel	$0	$0	$0	$0	$0	$0	$56,148	$56,148
Travel Overhead	$0	$0	$0	$0	$0	$0	$29,478	$29,478
Other - Tuition	$0	$43,616	$22,994	$5,994	$32,382	$0	$0	$104,986
Other - Subject Pay	$0	$0	$5,236	$9,360	$3,504	$0	$0	$18,100
Other - Publication Costs	$0	$0	$0	$0	$5,250	$0	$0	$5,250
Other Overhead	$0	$0	$2,749	$4,914	$4,596	$0	$0	$12,259
Subcontract Overhead	$13,125	$0	$0	$0	$0	$0	$0	$13,125
Total Cost	**$319,587**	**$646,797**	**$253,202**	**$209,158**	**$443,061**	**$224,527**	**$85,626**	**$2,181,957**

St. Joseph's Hospital and Medical Center

	1.1	1.2	1.3	1.4	1.5	1.6	1.7	Total
Direct Labor - Hrs	416	208	0	624	624	0	0	1,872
Direct Labor - Costs	$9,637	$4,819	$0	$14,817	$14,528	$0	$0	$43,801
Fringe Benefits	$2,891	$1,446	$0	$4,445	$4,358	$0	$0	$13,140
Total Labor Overhead	$8,866	$4,433	$0	$13,632	$13,366	$0	$0	$40,297
Other - Scans	$0	$0	$0	$24,000	$0	$0	$0	$24,000
Total Cost	**$21,394**	**$10,698**	**$0**	**$56,894**	**$32,252**	**$0**	**$0**	**$121,238**

Phase 2

Arizona State University

	2.1	2.2	2.3	2.4	2.5	2.6	Total
Direct Labor - Hrs	803	6,944	4,953	4,573	3,120	0	20,393
Direct Labor - Costs	$37,675	$214,283	$152,660	$152,025	$105,507	$0	$662,150
Fringe Benefits	$14,171	$70,872	$51,587	$59,154	$49,557	$0	$245,342
Total Labor Overhead	$27,220	$149,707	$107,229	$110,869	$81,408	$0	$476,433
Consultants	$0	$0	$0	$0	$0	$0	$0
Consultants Overhead	$0	$0	$0	$0	$0	$0	$0
Equipment	$0	$0	$0	$0	$0	$0	$0
Materials	$0	$0	$0	$0	$0	$0	$0
Materials Overhead	$0	$0	$0	$0	$0	$0	$0
Travel	$0	$0	$0	$0	$0	$39,198	$39,198
Travel Overhead	$0	$0	$0	$0	$0	$20,579	$20,579
Other - Tuition	$0	$43,956	$27,763	$10,825	$0	$0	$82,544
Other - Subject Pay	$0	$36,000	$6,400	$0	$0	$0	$42,400
Other - Publication Costs	$0	$0	$0	$5,250	$0	$0	$5,250
Other - Overhead	$0	$18,900	$3,360	$2,756	$0	$0	$25,016
Subcontract Overhead	$0	$0	$0	$0	$0	$0	$0
Total Cost	**$79,066**	**$533,718**	**$348,999**	**$340,880**	**$236,472**	**$59,777**	**$1,598,912**

St. Joseph's Hospital and Medical Center

	2.1	2.2	2.3	2.4	2.5	2.6	Total
Direct Labor - Hrs	104	1,134	452	182	0	0	1,872
Direct Labor - Costs	$2,482	$27,619	$11,063	$4,399	$0	$0	$45,563
Fringe Benefits	$745	$8,286	$3,319	$1,320	$0	$0	$13,669
Total Labor Overhead	$2,283	$25,409	$10,178	$4,047	$0	$0	$41,918
Other - Scans	$0	$135,000	$0	$0	$0	$0	$135,000
Total Cost	**$5,510**	**$196,314**	**$24,560**	**$9,766**	**$0**	**$0**	**$236,150**

Phase 3

Arizona State University

	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	Total
Direct Labor - Hrs	316	1,914	2,530	5,868	4,139	3,782	3,120	0	21,669
Direct Labor - Costs	$12,876	$63,173	$83,765	$165,989	$172,234	$160,052	$110,834	$0	$768,923
Fringe Benefits	$5,581	$22,376	$30,331	$57,912	$63,443	$61,246	$54,689	$0	$295,577
Total Labor Overhead	$9,690	$44,913	$59,900	$117,548	$123,730	$116,181	$86,899	$0	$558,862
Consultants	$0	$0	$0	$0	$0	$0	$0	$0	$0
Consultants Overhead	$0	$0	$0	$0	$0	$0	$0	$0	$0
Equipment	$151,796	$0	$0	$0	$0	$0	$0	$0	$151,796
Materials	$0	$0	$0	$0	$0	$0	$0	$0	$0
Materials Overhead	$0	$0	$0	$0	$0	$0	$0	$0	$0
Travel	$0	$0	$0	$0	$0	$0	$0	$55,646	$55,646
Travel Overhead	$0	$0	$0	$0	$0	$0	$0	$29,214	$29,214
Other - Tuition	$0	$10,596	$12,951	$35,796	$11,320	$8,490	$0	$0	$79,153
Other - Subject Pay	$0	$0	$0	$2,000	$0	$0	$0	$0	$2,000
Other - Publication Costs	$0	$0	$0	$0	$0	$750	$0	$0	$750
Other Overhead	$0	$0	$0	$1,050	$0	$394	$0	$0	$1,444
Subcontract Overhead	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Cost	**$179,943**	**$141,058**	**$186,948**	**$380,294**	**$370,726**	**$347,113**	**$252,422**	**$84,860**	**$1,943,364**

Phases 1-3

Arizona State University

Direct Labor - Hrs	70,948
Direct Labor - Costs	$2,257,326
Fringe Benefits	$784,414
Total Labor Overhead	$1,596,914
Consultants	$120,000
Consultants Overhead	$63,000
Equipment	$204,916
Materials	$49,262
Materials Overhead	$25,863
Travel	$150,992
Travel Overhead	$79,271
Other - Tuition	$266,683
Other - Subject Pay	$62,500
Other - Publication Costs	$11,250
Other Overhead	$38,719
Subcontract Overhead	$13,125
Total Cost	**$5,724,233**

St. Joseph's Hospital and Medical Center

Direct Labor - Hrs	3,744
Direct Labor - Costs	$89,364
Fringe Benefits	$26,809
Total Labor Overhead	$82,215
Other - Scans	$159,000
Total Cost	**$357,388**

Total Cost - Phases 1-3	**$6,081,622**

Government FY2012

Arizona State University

	1.1	1.2	1.3	1.4	1.5	1.6	1.7	Total
Direct Labor - Hrs	2,275	5,007	0	0	1,133	1,040	0	9,455
Direct Labor - Costs	$83,980	$124,494	$0	$0	$26,924	$33,475	$0	$268,872
Fringe Benefits	$32,884	$22,046	$0	$0	$9,359	$14,963	$0	$79,253
Total Labor Overhead	$61,354	$76,933	$0	$0	$19,048	$25,430	$0	$182,765
Consultants	$0	$60,000	$0	$0	$0	$0	$0	$60,000
Consultants Overhead	$0	$31,500	$0	$0	$0	$0	$0	$31,500
Equipment	$53,120	$0	$0	$0	$0	$0	$0	$53,120
Materials	$49,262	$0	$0	$0	$0	$0	$0	$49,262
Materials Overhead	$25,863	$0	$0	$0	$0	$0	$0	$25,863
Travel	$0	$0	$0	$0	$0	$0	$22,564	$22,564
Travel Overhead	$0	$0	$0	$0	$0	$0	$11,846	$11,846
Other - Tuition	$0	$32,400	$0	$0	$4,985	$0	$0	$37,385
Other - Subject Pay	$0	$0	$0	$0	$0	$0	$0	$0
Other - Publication Costs	$0	$0	$0	$0	$0	$0	$0	$0
Other Overhead	$0	$0	$0	$0	$0	$0	$0	$0
Subcontract Overhead	$13,125	$0	$0	$0	$0	$0	$0	$13,125
Total Cost	**$319,587**	**$347,373**	**$0**	**$0**	**$60,316**	**$73,868**	**$34,410**	**$835,554**

St. Joseph's Hospital and Medical Center

	1.1	1.2	1.3	1.4	1.5	1.6	1.7	Total
Direct Labor - Hrs	416	0	0	0	208	0	0	624
Direct Labor - Costs	$9,637	$0	$0	$0	$4,819	$0	$0	$14,456
Fringe Benefits	$2,891	$0	$0	$0	$1,446	$0	$0	$4,337
Total Labor Overhead	$8,866	$0	$0	$0	$4,433	$0	$0	$13,300
Other - Scans	$0	$0	$0	$0	$0	$0	$0	$0
Total Cost	**$21,394**	**$0**	**$0**	**$0**	**$10,698**	**$0**	**$0**	**$32,092**

Government FY2013

Arizona State University

	1.1	1.2	1.3	1.4	1.5	1.6	1.7	Total
Direct Labor - Hrs	0	4,662	4,223	2,462	6,004	2,080	0	19,431
Direct Labor - Costs	$0	$110,236	$112,970	$91,748	$174,472	$67,955	$0	$557,381
Fringe Benefits	$0	$18,753	$32,750	$32,114	$49,789	$30,838	$0	$164,243
Total Labor Overhead	$0	$67,719	$76,503	$65,028	$117,737	$51,866	$0	$378,853
Consultants	$0	$60,000	$0	$0	$0	$0	$0	$60,000
Consultants Overhead	$0	$31,500	$0	$0	$0	$0	$0	$31,500
Equipment	$0	$0	$0	$0	$0	$0	$0	$0
Materials	$0	$0	$0	$0	$0	$0	$0	$0
Materials Overhead	$0	$0	$0	$0	$0	$0	$0	$0
Travel	$0	$0	$0	$0	$0	$0	$33,584	$33,584
Travel Overhead	$0	$0	$0	$0	$0	$0	$17,632	$17,632
Other - Tuition	$0	$11,216	$22,994	$5,994	$27,397	$0	$0	$67,601
Other - Subject Pay	$0	$0	$5,236	$9,360	$3,504	$0	$0	$18,100
Other - Publication Costs	$0	$0	$0	$0	$5,250	$0	$0	$5,250
Other Overhead	$0	$0	$2,749	$4,914	$4,596	$0	$0	$12,259
Subcontract Overhead	$0	$0	$0	$0	$0	$0	$0	$0
Total Cost	**$0**	**$299,424**	**$253,202**	**$209,158**	**$382,745**	**$150,659**	**$51,216**	**$1,346,402**

St. Joseph's Hospital and Medical Center

	1.1	1.2	1.3	1.4	1.5	1.6	1.7	Total
Direct Labor - Hrs	0	208	0	624	416	0	0	1248
Direct Labor - Costs	$0	$4,818	$0	$14,817	$9,710	$0	$0	$29,345
Fringe Benefits	$0	$1,445	$0	$4,445	$2,913	$0	$0	$8,804
Total Labor Overhead	$0	$4,433	$0	$13,632	$8,933	$0	$0	$26,997
Other - Scans	$0	$0	$0	$24,000	$0	$0	$0	$24,000
Total Cost	**$0**	**$10,696**	**$0**	**$56,894**	**$21,556**	**$0**	**$0**	**$89,146**

Government FY2014

Arizona State University

	2.1	2.2	2.3	2.4	2.5	2.6	Total
Direct Labor - Hrs	803	4,644	3,333	2,765	2,080	0	13,625
Direct Labor - Costs	$37,675	$148,533	$100,518	$83,899	$69,993	$0	$440,619
Fringe Benefits	$14,171	$49,620	$33,408	$32,515	$32,716	$0	$162,432
Total Labor Overhead	$27,220	$104,031	$70,311	$61,118	$53,922	$0	$316,601
Consultants	$0	$0	$0	$0	$0	$0	$0
Consultants Overhead	$0	$0	$0	$0	$0	$0	$0
Equipment	$0	$0	$0	$0	$0	$0	$0
Materials	$0	$0	$0	$0	$0	$0	$0
Materials Overhead	$0	$0	$0	$0	$0	$0	$0
Travel	$0	$0	$0	$0	$0	$32,708	$32,708
Travel Overhead	$0	$0	$0	$0	$0	$17,172	$17,172
Other - Tuition	$0	$28,694	$20,132	$7,554	$0	$0	$56,380
Other - Subject Pay	$0	$24,000	$4,655	$0	$0	$0	$28,655
Other - Publication Costs	$0	$0	$0	$0	$0	$0	$0
Other Overhead	$0	$12,600	$2,444	$0	$0	$0	$15,044
Subcontract Overhead	$0	$0	$0	$0	$0	$0	$0
Total Cost	**$79,066**	**$367,478**	**$231,468**	**$185,086**	**$156,631**	**$49,880**	**$1,069,610**

St. Joseph's Hospital and Medical Center

	2.1	2.2	2.3	2.4	2.5	2.6	Total
Direct Labor - Hrs	104	728	312	104	0	0	1,248
Direct Labor - Costs	$2,482	$17,650	$7,612	$2,482	$0	$0	$30,226
Fringe Benefits	$745	$5,295	$2,284	$745	$0	$0	$9,068
Total Labor Overhead	$2,283	$16,238	$7,003	$2,283	$0	$0	$27,808
Other - Scans	$0	$0	$0	$135,000	$0	$0	$135,000
Total Cost	**$5,510**	**$39,183**	**$16,899**	**$140,510**	**$0**	**$0**	**$202,102**

Government FY2015

Arizona State University

	2.1	2.2	2.3	2.4	2.5	2.6	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	Total
Direct Labor - Hrs	0	2,300	1,620	1,808	1,040	0	316	1,914	2,530	744	0	173	1,040	0	13,485
Direct Labor - Costs	$0	$65,750	$52,142	$68,126	$35,514	$0	$12,876	$63,173	$83,765	$20,823	$0	$9,272	$36,579	$0	$448,020
Fringe Benefits	$0	$21,252	$18,179	$26,639	$16,841	$0	$5,581	$22,376	$30,331	$7,263	$0	$3,717	$17,867	$0	$170,045
Total Labor Overhead	$0	$45,676	$36,918	$49,752	$27,486	$0	$9,690	$44,913	$59,900	$14,745	$0	$6,819	$28,584	$0	$324,484
Consultants	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Consultants Overhead	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Equipment	$0	$0	$0	$0	$0	$0	$151,796	$0	$0	$0	$0	$0	$0	$0	$151,796
Materials	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Materials Overhead	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Travel	$0	$0	$0	$0	$0	$6,490	$0	$0	$0	$0	$0	$0	$0	$22,326	$28,816
Travel Overhead	$0	$0	$0	$0	$0	$3,407	$0	$0	$0	$0	$0	$0	$0	$11,721	$15,128
Other - Tuition	$0	$15,262	$7,631	$3,270	$0	$0	$0	$10,596	$12,951	$4,709	$0	$0	$0	$0	$54,419
Other - Subject Pay	$0	$12,000	$1,745	$0	$0	$0	$0	$0	$0	$250	$0	$0	$0	$0	$13,995
Other - Publication Costs	$0	$0	$0	$5,250	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,250
Other Overhead	$0	$6,300	$916	$2,756	$0	$0	$0	$0	$0	$131	$0	$0	$0	$0	$10,104
Subcontract Overhead	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Cost	**$0**	**$166,239**	**$117,531**	**$155,793**	**$79,841**	**$9,897**	**$179,943**	**$141,058**	**$186,948**	**$47,921**	**$0**	**$19,809**	**$83,030**	**$34,047**	**$1,222,057**

St. Joseph's Hospital and Medical Center

	2.1	2.2	2.3	2.4	2.5	2.6	Total
Direct Labor - Hrs	0	406	140	78	0	0	624
Direct Labor - Costs	$0	$9,969	$3,451	$1,917	$0	$0	$15,337
Fringe Benefits	$0	$2,991	$1,035	$575	$0	$0	$4,601
Total Labor Overhead	$0	$9,171	$3,175	$1,764	$0	$0	$14,110
Other - Scans	$0	$0	$0	$0	$0	$0	$0
Total Cost	**$0**	**$22,131**	**$7,661**	**$4,256**	**$0**	**$0**	$34,048

Government FY2016

Arizona State University

	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.7	Total
Direct Labor - Hrs	0	0	0	5,124	4,139	3,609	2,080	0	14,952
Direct Labor - Costs	$0	$0	$0	$145,166	$172,234	$150,780	$74,255	$0	$542,435
Fringe Benefits	$0	$0	$0	$50,649	$63,443	$57,528	$36,822	$0	$208,442
Total Labor Overhead	$0	$0	$0	$102,803	$123,730	$109,362	$58,315	$0	$394,210
Consultants	$0	$0	$0	$0	$0	$0	$0	$0	$0
Consultants Overhead	$0	$0	$0	$0	$0	$0	$0	$0	$0
Equipment	$0	$0	$0	$0	$0	$0	$0	$0	$0
Materials	$0	$0	$0	$0	$0	$0	$0	$0	$0
Materials Overhead	$0	$0	$0	$0	$0	$0	$0	$0	$0
Travel	$0	$0	$0	$0	$0	$0	$0	$33,320	$33,320
Travel Overhead	$0	$0	$0	$0	$0	$0	$0	$17,493	$17,493
Other - Tuition	$0	$0	$0	$31,087	$11,320	$8,490	$0	$0	$50,897
Other - Subject Pay	$0	$0	$0	$1,750	$0	$0	$0	$0	$1,750
Other - Publication Costs	$0	$0	$0	$0	$0	$750	$0	$0	$750
Other Overhead	$0	$0	$0	$919	$0	$394	$0	$0	$1,313
Subcontract Overhead	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Cost	**$0**	**$0**	**$0**	**$332,373**	**$370,726**	**$327,305**	**$169,392**	**$50,813**	**$1,250,609**

Government FY2012-2016

Arizona State University

Direct Labor - Hrs	70,948
Direct Labor - Costs	$2,257,326
Fringe Benefits	$784,414
Total Labor Overhead	$1,596,914
Consultants	$120,000
Consultants Overhead	$63,000
Equipment	$204,916
Materials	$49,262
Materials Overhead	$25,863
Travel	$150,992
Travel Overhead	$79,271
Other - Tuition	$266,682
Other - Subject Pay	$62,500
Other - Publication Costs	$11,250
Other Overhead	$38,719
Subcontract Overhead	$13,125
Total Cost	**$5,724,232**

St. Joseph's Hospital and Medical Center

Direct Labor - Hrs	3,744
Direct Labor - Costs	$89,364
Fringe Benefits	$26,809
Total Labor Overhead	$82,215
Other - Scans	$159,000
Total Cost	**$357,388**

Total Cost - GFY2012-2016	**$6,081,621**

Calendar FY2012

Arizona State University

	1.1	1.2	1.3	1.4	1.5	1.6	1.7	Total
Direct Labor - Hrs	2,275	7,000	499	0	2,849	1,560	0	14,183
Direct Labor - Costs	$83,980	$184,779	$16,545	$0	$67,792	$50,213	$0	$403,308
Fringe Benefits	$32,884	$35,773	$4,163	$0	$23,613	$22,445	$0	$118,879
Total Labor Overhead	$61,354	$115,790	$10,872	$0	$47,988	$38,145	$0	$274,148
Consultants	$0	$120,000	$0	$0	$0	$0	$0	$120,000
Consultants Overhead	$0	$63,000	$0	$0	$0	$0	$0	$63,000
Equipment	$53,120	$0	$0	$0	$0	$0	$0	$53,120
Materials	$49,262	$0	$0	$0	$0	$0	$0	$49,262
Materials Overhead	$25,863	$0	$0	$0	$0	$0	$0	$25,863
Travel	$0	$0	$0	$0	$0	$0	$27,756	$27,756
Travel Overhead	$0	$0	$0	$0	$0	$0	$14,572	$14,572
Other - Tuition	$0	$39,877	$3,739	$0	$12,462	$0	$0	$56,078
Other - Subject Pay	$0	$0	$0	$0	$0	$0	$0	$0
Other - Publication Costs	$0	$0	$0	$0	$0	$0	$0	$0
Other Overhead	$0	$0	$0	$0	$0	$0	$0	$0
Subcontract Overhead	$13,125	$0	$0	$0	$0	$0	$0	$13,125
Total Cost	**$319,587**	**$559,219**	**$35,319**	**$0**	**$151,855**	**$110,803**	**$42,328**	**$1,219,110**

St. Joseph's Hospital and Medical Center

	1.1	1.2	1.3	1.4	1.5	1.6	1.7	Total
Direct Labor - Hrs	416	104	0	0	416	0	0	936
Direct Labor - Costs	$9,637	$2,409	$0	$0	$9,638	$0	$0	$21,684
Fringe Benefits	$2,891	$723	$0	$0	$2,891	$0	$0	$6,505
Total Labor Overhead	$8,866	$2,216	$0	$0	$8,867	$0	$0	$19,949
Other - Scans	$0	$0	$0	$12,000	$0	$0	$0	$12,000
Total Cost	**$21,394**	**$5,348**	**$0**	**$12,000**	**$21,396**	**$0**	**$0**	**$60,138**

Calendar FY2013

Arizona State University

	1.1	1.2	1.3	1.4	1.5	1.6	1.7	2.1	2.2	2.3	2.4	2.5	2.6	Total
Direct Labor - Hrs	0	2,669	3,725	2,462	4,288	1,560	0	803	657	0	1,447	520	0	18,131
Direct Labor - Costs	$0	$49,951	$96,425	$91,748	$133,604	$51,217	$0	$0	$37,675	$20,756	$33,873	$17,240	$0	$532,489
Fringe Benefits	$0	$5,026	$28,587	$32,114	$35,534	$23,356	$0	$0	$14,171	$6,315	$11,337	$7,937	$0	$164,378
Total Labor Overhead	$0	$28,863	$65,631	$65,028	$88,798	$39,151	$0	$0	$27,220	$14,212	$23,735	$13,218	$0	$365,855
Consultants	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Consultants Overhead	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Equipment	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Materials	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Materials Overhead	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Travel	$0	$0	$0	$0	$0	$0	$28,392	$0	$0	$0	$0	$0	$6,582	$34,974
Travel Overhead	$0	$0	$0	$0	$0	$0	$14,906	$0	$0	$0	$0	$0	$3,456	$18,361
Other - Tuition	$0	$3,739	$19,256	$5,994	$19,920	$0	$0	$0	$7,554	$0	$7,554	$0	$0	$64,017
Other - Subject Pay	$0	$0	$5,236	$9,360	$3,504	$0	$0	$0	$2,400	$0	$0	$0	$0	$20,500
Other - Publication Costs	$0	$0	$0	$0	$5,250	$0	$0	$0	$0	$0	$0	$0	$0	$5,250
Other Overhead	$0	$0	$2,749	$4,914	$4,596	$0	$0	$0	$1,260	$0	$0	$0	$0	$13,519
Subcontract Overhead	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Cost	**$0**	**$87,578**	**$217,884**	**$209,158**	**$291,206**	**$113,724**	**$43,298**	**$0**	**$90,280**	**$41,283**	**$76,498**	**$38,395**	**$10,038**	**$1,219,342**

St. Joseph's Hospital and Medical Center

	1.1	1.2	1.3	1.4	1.5	1.6	1.7	2.1	2.2	2.3	2.4	2.5	2.6	Total
Direct Labor - Hrs	0	104	0	624	208	0	0	104	104	0	104	0	0	1,248
Direct Labor - Costs	$0	$2,409	$0	$14,817	$4,891	$0	$0	$2,482	$2,482	$0	$2,482	$0	$0	$29,563
Fringe Benefits	$0	$723	$0	$4,445	$1,467	$0	$0	$745	$745	$0	$745	$0	$0	$8,869
Total Labor Overhead	$0	$2,216	$0	$13,632	$4,500	$0	$0	$2,283	$2,283	$0	$2,283	$0	$0	$27,198
Other - Scans	$0	$0	$0	$12,000	$0	$0	$0	$0	$37,500	$0	$0	$0	$0	$49,500
Total Cost	**$0**	**$5,348**	**$0**	**$44,894**	**$10,858**	**$0**	**$0**	**$5,510**	**$43,010**	**$0**	**$5,510**	**$0**	**$0**	**$115,130**

Calendar FY2014

Arizona State University

	2.1	2.2	2.3	2.4	2.5	2.6	Total
Direct Labor - Hrs	0	5,330	4,412	1,760	2,080	0	13,582
Direct Labor - Costs	$0	$166,005	$138,739	$66,587	$70,510	$0	$441,841
Fringe Benefits	$0	$55,776	$46,884	$28,267	$33,199	$0	$164,126
Total Labor Overhead	$0	$116,435	$97,452	$49,798	$54,447	$0	$318,133
Consultants	$0	$0	$0	$0	$0	$0	$0
Consultants Overhead	$0	$0	$0	$0	$0	$0	$0
Equipment	$0	$0	$0	$0	$0	$0	$0
Materials	$0	$0	$0	$0	$0	$0	$0
Materials Overhead	$0	$0	$0	$0	$0	$0	$0
Travel	$0	$0	$0	$0	$0	$28,616	$28,616
Travel Overhead	$0	$0	$0	$0	$0	$15,023	$15,023
Other - Tuition	$0	$29,861	$24,493	$0	$0	$0	$54,354
Other - Subject Pay	$0	$28,800	$5,818	$0	$0	$0	$34,618
Other - Publication Costs	$0	$0	$0	$0	$0	$0	$0
Other Overhead	$0	$15,120	$3,054	$0	$0	$0	$18,174
Subcontract Overhead	$0	$0	$0	$0	$0	$0	$0
Total Cost	**$0**	**$411,996**	**$316,441**	**$144,651**	**$158,157**	**$43,639**	**$1,074,885**

St. Joseph's Hospital and Medical Center

	2.1	2.2	2.3	2.4	2.5	2.6	Total
Direct Labor - Hrs	0	874	374	0	0	0	1,248
Direct Labor - Costs	$0	$21,303	$9,146	$0	$0	$0	$30,449
Fringe Benefits	$0	$6,391	$2,744	$0	$0	$0	$9,135
Total Labor Overhead	$0	$19,599	$8,414	$0	$0	$0	$28,013
Other - Scans	$0	$97,500	$0	$0	$0	$0	$97,500
Total Cost	**$0**	**$144,793**	**$20,304**	**$0**	**$0**	**$0**	**$165,097**

Calendar FY2015

Arizona State University

	2.1	2.2	2.3	2.4	2.5	2.6	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	Total
Direct Labor - Hrs	0	957	541	1,366	520	0	316	1,914	2,530	2,976	260	520	1,560	0	13,460
Direct Labor - Costs	$0	$27,522	$13,920	$51,566	$17,757	$0	$12,876	$63,173	$83,765	$83,292	$17,586	$24,172	$54,869	$0	$450,499
Fringe Benefits	$0	$8,782	$4,702	$19,551	$8,421	$0	$5,581	$22,376	$30,331	$29,050	$6,380	$10,183	$26,800	$0	$172,157
Total Labor Overhead	$0	$19,060	$9,777	$37,336	$13,743	$0	$9,690	$44,913	$59,900	$58,980	$12,582	$18,036	$42,876	$0	$326,894
Consultants	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Consultants Overhead	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Equipment	$0	$0	$0	$0	$0	$0	$151,796	$0	$0	$0	$0	$0	$0	$0	$151,796
Materials	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Materials Overhead	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Travel	$0	$0	$0	$0	$0	$4,000	$0	$0	$0	$0	$0	$0	$0	$25,646	$29,646
Travel Overhead	$0	$0	$0	$0	$0	$2,100	$0	$0	$0	$0	$0	$0	$0	$13,464	$15,564
Other - Tuition	$0	$6,541	$3,270	$3,270	$0	$0	$0	$10,596	$12,951	$18,838	$0	$0	$0	$0	$55,466
Other - Subject Pay	$0	$4,800	$582	$0	$0	$0	$0	$0	$0	$1,000	$0	$0	$0	$0	$6,382
Other - Publication Costs	$0	$0	$0	$5,250	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,250
Other Overhead	$0	$2,520	$306	$2,756	$0	$0	$0	$0	$0	$525	$0	$0	$0	$0	$6,107
Subcontract Overhead	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Cost	**$0**	**$69,224**	**$32,557**	**$119,729**	**$39,921**	**$6,100**	**$179,943**	**$141,058**	**$186,948**	**$191,686**	**$36,548**	**$52,391**	**$124,545**	**$39,110**	**$1,219,760**

St. Joseph's Hospital and Medical Center

	2.1	2.2	2.3	2.4	2.5	2.6	Total
Direct Labor - Hrs	0	156	78	78	0	0	312
Direct Labor - Costs	$0	$3,834	$1,917	$1,917	$0	$0	$7,668
Fringe Benefits	$0	$1,150	$575	$575	$0	$0	$2,300
Total Labor Overhead	$0	$3,527	$1,764	$1,764	$0	$0	$7,055
Other - Scans	$0	$0	$0	$0	$0	$0	$0
Total Cost	**$0**	**$8,511**	**$4,256**	**$4,256**	**$0**	**$0**	**$17,023**

Calendar FY2016

Arizona State University

	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	Total
Direct Labor - Hrs	0	0	0	2,893	3,879	3,261	1,560	0	11,593
Direct Labor - Costs	$0	$0	$0	$82,697	$154,648	$135,881	$55,966	$0	$429,190
Fringe Benefits	$0	$0	$0	$28,861	$57,063	$51,062	$27,888	$0	$164,875
Total Labor Overhead	$0	$0	$0	$58,568	$111,148	$98,145	$44,023	$0	$311,884
Consultants	$0	$0	$0	$0	$0	$0	$0	$0	$0
Consultants Overhead	$0	$0	$0	$0	$0	$0	$0	$0	$0
Equipment	$0	$0	$0	$0	$0	$0	$0	$0	$0
Materials	$0	$0	$0	$0	$0	$0	$0	$0	$0
Materials Overhead	$0	$0	$0	$0	$0	$0	$0	$0	$0
Travel	$0	$0	$0	$0	$0	$0	$0	$30,000	$30,000
Travel Overhead	$0	$0	$0	$0	$0	$0	$0	$15,750	$15,750
Other - Tuition	$0	$0	$0	$16,958	$11,320	$8,490	$0	$0	$36,768
Other - Subject Pay	$0	$0	$0	$1,000	$0	$0	$0	$0	$1,000
Other - Publication Costs	$0	$0	$0	$0	$0	$750	$0	$0	$750
Other Overhead	$0	$0	$0	$525	$0	$394	$0	$0	$919
Subcontract Overhead	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Cost	**$0**	**$0**	**$0**	**$188,608**	**$334,178**	**$294,722**	**$127,877**	**$45,750**	**$991,136**

Calendar FY2012-2016

Arizona State University

Direct Labor - Hrs	70,949
Direct Labor - Costs	$2,257,326
Fringe Benefits	$784,414
Total Labor Overhead	$1,596,914
Consultants	$120,000
Consultants Overhead	$63,000
Equipment	$204,916
Materials	$49,262
Materials Overhead	$25,863
Travel	$150,992
Travel Overhead	$79,271
Other - Tuition	$266,683
Other - Subject Pay	$62,500
Other - Publication Costs	$11,250
Other Overhead	$38,719
Subcontract Overhead	$13,125
Total Cost	**$5,724,233**

St. Joseph's Hospital and Medical Center

Direct Labor - Hrs	3,744
Direct Labor - Costs	$89,364
Fringe Benefits	$26,809
Total Labor Overhead	$82,215
Other - Scans	$159,000
Total Cost	**$357,388**

Total Cost - Phases 1-3	**$6,081,622**

Cost Breakdown by Months (1-18)

Arizona State University

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
	Apr-12	**May-12**	**Jun-12**	**Jul-12**	**Aug-12**	**Sep-12**	**Oct-12**	**Nov-12**	**Dec-12**	**Jan-13**	**Feb-13**	**Mar-13**	**Apr-13**	**May-13**	**Jun-13**	**Jul-13**	**Aug-13**	**Sep-13**	Total
Direct Labor - Costs	$45 903	$45 903	$45 903	$45 903	$45 903	$45 903	$45 903	$45 903	$45 903	$45 903	$45 903	$45 903	$45 903	$45 903	$45 903	$45 903	$45 903	$45 903	$826 253
Fringe Benefits	$13,528	$13,528	$13,528	$13,528	$13,528	$13,528	$13,528	$13,528	$13,528	$13,528	$13,528	$13,528	$13,528	$13,528	$13,528	$13,528	$13,528	$13,528	$243,496
Total Labor Overhead	$31 201	$31 201	$31 201	$31 201	$31 201	$31 201	$31 201	$31 201	$31 201	$31 201	$31 201	$31 201	$31 201	$31 201	$31 201	$31 201	$31 201	$31 201	$561 618
Consultants	$6 667	$6 667	$6 667	$6 667	$6 667	$6 667	$6 667	$6 667	$6 667	$6 667	$6 667	$6 667	$6 667	$6 667	$6 667	$6 667	$6 667	$6 667	$120 000
Consultants Overhead	$3,500	$3,500	$3,500	$3,500	$3,500	$3,500	$3,500	$3,500	$3,500	$3,500	$3,500	$3,500	$3,500	$3,500	$3,500	$3,500	$3,500	$3,500	$63,000
Equipment	$53 120	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$53 120
Materials	$49,262	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$49,262
Materials Overhead	$25 863	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$25 863
Travel	$11,504	$1,200	$9,860	$0	$0	$0	$2,672	$2,520	$0	$4,580	$0	$0	$0	$0	$23,812	$0	$0	$0	$56,148
Travel Overhead	$6 040	$630	$5 177	$0	$0	$0	$1 403	$1 323	$0	$2 405	$0	$0	$0	$0	$12 501	$0	$0	$0	$29 478
Other - Tuition	$5,833	$5,833	$5,833	$5,833	$5,833	$5,833	$5,833	$5,833	$5,833	$5,833	$5,833	$5,833	$5,833	$5,833	$5,833	$5,833	$5,833	$5,833	$104,986
Other - Subject Pay	$1 006	$1 006	$1 006	$1 006	$1 006	$1 006	$1 006	$1 006	$1 006	$1 006	$1 006	$1 006	$1 006	$1 006	$1 006	$1 006	$1 006	$1 006	$18 100
Other - Publication Costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$2 625	$2 625	$5 250
Other Overhead	$528	$528	$528	$528	$528	$528	$528	$528	$528	$528	$528	$528	$528	$528	$528	$528	$1,906	$1,906	$12,259
Subcontract Overhead	$13 125	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$13 125
Total Cost	**$267,077**	**$109,994**	**$123,201**	**$108,164**	**$108,164**	**$108,164**	**$112,239**	**$112,007**	**$108,164**	**$115,149**	**$108,164**	**$108,164**	**$108,164**	**$108,164**	**$144,478**	**$108,164**	**$112,167**	**$112,167**	**$2,181,957**

St. Joseph's Hospital and Medical Center

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
	Apr-12	**May-12**	**Jun-12**	**Jul-12**	**Aug-12**	**Sep-12**	**Oct-12**	**Nov-12**	**Dec-12**	**Jan-13**	**Feb-13**	**Mar-13**	**Apr-13**	**May-13**	**Jun-13**	**Jul-13**	**Aug-13**	**Sep-13**	Total
Direct Labor - Costs	$2 433	$2 433	$2 433	$2 433	$2 433	$2 433	$2 433	$2 433	$2 433	$2 433	$2 433	$2 433	$2 433	$2 433	$2 433	$2 433	$2 433	$2 433	$43 801
Fringe Benefits	$730	$730	$730	$730	$730	$730	$730	$730	$730	$730	$730	$730	$730	$730	$730	$730	$730	$730	$13,140
Total Labor Overhead	$2 239	$2 239	$2 239	$2 239	$2 239	$2 239	$2 239	$2 239	$2 239	$2 239	$2 239	$2 239	$2 239	$2 239	$2 239	$2 239	$2 239	$2 239	$40 297
Other - Scans	$1,333	$1,333	$1,333	$1,333	$1,333	$1,333	$1,333	$1,333	$1,333	$1,333	$1,333	$1,333	$1,333	$1,333	$1,333	$1,333	$1,333	$1,333	$24,000
Total Cost	**$6,735**	**$6,735**	**$6,735**	**$6,735**	**$6,735**	**$6,735**	**$6,735**	**$6,735**	**$6,735**	**$6,735**	**$6,735**	**$6,735**	**$6,735**	**$6,735**	**$6,735**	**$6,735**	**$6,735**	**$6,735**	**$121,238**

Cost Breakdown by Months (19-36)

Arizona State University

	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
	Oct-13	**Nov-13**	**Dec-13**	**Jan-14**	**Feb-14**	**Mar-14**	**Apr-14**	**May-14**	**Jun-14**	**Jul-14**	**Aug-14**	**Sep-14**	**Oct-14**	**Nov-14**	**Dec-14**	**Jan-15**	**Feb-15**	**Mar-15**	Total
Direct Labor - Costs	$36,786	$36,786	$36,786	$36,786	$36,786	$36,786	$36,786	$36,786	$36,786	$36,786	$36,786	$36,786	$36,786	$36,786	$36,786	$36,786	$36,786	$36,786	$662,150
Fringe Benefits	$13,630	$13,630	$13,630	$13,630	$13,630	$13,630	$13,630	$13,630	$13,630	$13,630	$13,630	$13,630	$13,630	$13,630	$13,630	$13,630	$13,630	$13,630	$245,342
Total Labor Overhead	$26,469	$26,469	$26,469	$26,469	$26,469	$26,469	$26,469	$26,469	$26,469	$26,469	$26,469	$26,469	$26,469	$26,469	$26,469	$26,469	$26,469	$26,469	$476,433
Consultants	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Consultants Overhead	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Equipment	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Materials	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Materials Overhead	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Travel	$1,466	$5,116	$0	$4,000	$0	$0	$0	$3,640	$18,486	$0	$0	$0	$0	$2,490	$0	$4,000	$0	$0	$39,198
Travel Overhead	$770	$2,686	$0	$2,100	$0	$0	$0	$1,911	$9,705	$0	$0	$0	$0	$1,307	$0	$2,100	$0	$0	$20,579
Other - Tuition	$4,586	$4,586	$4,586	$4,586	$4,586	$4,586	$4,586	$4,586	$4,586	$4,586	$4,586	$4,586	$4,586	$4,586	$4,586	$4,586	$4,586	$4,586	$82,544
Other - Subject Pay	$2,356	$2,356	$2,356	$2,356	$2,356	$2,356	$2,356	$2,356	$2,356	$2,356	$2,356	$2,356	$2,356	$2,356	$2,356	$2,356	$2,356	$2,356	$42,400
Other - Publication Costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$2,625	$2,625	$5,250
Other Overhead	$1,237	$1,237	$1,237	$1,237	$1,237	$1,237	$1,237	$1,237	$1,237	$1,237	$1,237	$1,237	$1,237	$1,237	$1,237	$1,237	$2,615	$2,615	$25,016
Subcontract Overhead	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Cost	**$87,298**	**$92,865**	**$85,063**	**$91,163**	**$85,063**	**$85,063**	**$85,063**	**$90,614**	**$113,254**	**$85,063**	**$85,063**	**$85,063**	**$85,063**	**$88,860**	**$85,063**	**$91,163**	**$89,066**	**$89,066**	**$1,598,913**

St. Joseph's Hospital and Medical Center

	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
	Oct-13	**Nov-13**	**Dec-13**	**Jan-14**	**Feb-14**	**Mar-14**	**Apr-14**	**May-14**	**Jun-14**	**Jul-14**	**Aug-14**	**Sep-14**	**Oct-14**	**Nov-14**	**Dec-14**	**Jan-15**	**Feb-15**	**Mar-15**	Total
Direct Labor - Costs	$2,531	$2,531	$2,531	$2,531	$2,531	$2,531	$2,531	$2,531	$2,531	$2,531	$2,531	$2,531	$2,531	$2,531	$2,531	$2,531	$2,531	$2,531	$45 563
Fringe Benefits	$759	$759	$759	$759	$759	$759	$759	$759	$759	$759	$759	$759	$759	$759	$759	$759	$759	$759	$13,669
Total Labor Overhead	$2,329	$2,329	$2,329	$2,329	$2,329	$2,329	$2,329	$2,329	$2,329	$2,329	$2,329	$2,329	$2,329	$2,329	$2,329	$2,329	$2,329	$2,329	$41,918
Other - Scans	$7,500	$7,500	$7,500	$7,500	$7,500	$7 500	$7,500	$7,500	$7,500	$7,500	$7,500	$7,500	$7 500	$7,500	$7,500	$7,500	$7,500	$7,500	$135,000
Total Cost	$13,119	$13,119	$13,119	$13,119	$13,119	$13,119	$13,119	$13,119	$13,119	$13,119	$13,119	$13,119	$13,119	$13,119	$13,119	$13,119	$13,119	$13,119	$236,150

Cost Breakdown by Months (37-54)

Arizona State University

	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	
	Apr-15	**May-15**	**Jun-15**	**Jul-15**	**Aug-15**	**Sep-15**	**Oct-15**	**Nov-15**	**Dec-15**	**Jan-16**	**Feb-16**	**Mar-16**	**Apr-16**	**May-16**	**Jun-16**	**Jul-16**	**Aug-16**	**Sep-16**	Total
Direct Labor - Costs	$42,718	$42,718	$42,718	$42,718	$42,718	$42,718	$42,718	$42,718	$42,718	$42,718	$42,718	$42,718	$42,718	$42,718	$42,718	$42,718	$42,718	$42,718	$768,923
Fringe Benefits	$16,421	$16,421	$16,421	$16,421	$16,421	$16,421	$16,421	$16,421	$16,421	$16,421	$16,421	$16,421	$16,421	$16,421	$16,421	$16,421	$16,421	$16,421	$295,577
Total Labor Overhead	$31,048	$31,048	$31 048	$31,048	$31,048	$31,048	$31 048	$31,048	$31,048	$31,048	$31 048	$31,048	$31,048	$31,048	$31 048	$31,048	$31,048	$31,048	$558,863
Consultants	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Consultants Overhead	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Equipment	$151,796	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$151,796
Materials	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Materials Overhead	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Travel	$1,438	$4,888	$16,000	$0	$0	$0	$0	$3,320	$0	$8,000	$0	$0	$0	$6,000	$16,000	$0	$0	$0	$55,646
Travel Overhead	$755	$2,566	$8,400	$0	$0	$0	$0	$1,743	$0	$4,200	$0	$0	$0	$3,150	$8,400	$0	$0	$0	$29,214
Other - Tui ion	$4,397	$4,397	$4,397	$4,397	$4,397	$4,397	$4,397	$4,397	$4,397	$4,397	$4,397	$4,397	$4,397	$4,397	$4,397	$4,397	$4,397	$4,397	$79,153
Other - Subject Pay	$111	$111	$111	$111	$111	$111	$111	$111	$111	$111	$111	$111	$111	$111	$111	$111	$111	$111	$2,000
Other - Publication Costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$250	$250	$250	$750
Other Overhead	$58	$58	$58	$58	$58	$58	$58	$58	$58	$58	$58	$58	$58	$58	$58	$190	$190	$190	$1,444
Subcontract Overhead	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Cost	**$248,743**	**$102,208**	**$119,154**	**$94,754**	**$94,754**	**$94,754**	**$94,754**	**$99,817**	**$94,754**	**$106,954**	**$94,754**	**$94,754**	**$94,754**	**$103,904**	**$119,154**	**$95,135**	**$95,135**	**$95,135**	**$1,943,365**

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INNOVATION

James G. Pipe, Ph.D.
Director, Neuroimaging Research
[redacted]

November 18, 2011

Dear Drs. Corman and Baxter,

I am pleased to write this letter of support for your grant proposal, "Mapping the Narrative Comprehension Network: Towards Narrative Disruptors and Inductors," which you are submitting to DARPA. It's great to see faculty work across institutions like this, which is a rich part of the history between Arizona State University and the Barrow Neurological Institute.

I am also very pleased that the Keller Center for Imaging Innovation will play a part in this important work. We built this center as a place not only to develop new MRI methods, but also to serve as an imaging resource for investigators across the Phoenix valley, with a desire to foster inter-institutional collaborations such as this. I understand you want to scan 40 patients in the first few months, and 160 in the next phase, lasting approximately 18 months. We can certainly accommodate these scans, and appreciate your desire to work with us. As we discussed, the cost for your exams (1.5 hours) is $750 per scan.

Best of luck with your submission-

[redacted]

James Pipe, Ph.D.
Director, Neuroimaging Research
Barrow Neurological Institute
[redacted]

Budget Justification

Personnel

Principal Investigator – Dr. Steven Corman will dedicate 3 months per year to the project. Dr. Corman will take the role of leading and monitoring the research project team, and creating synergy across all the areas to reach the research goals. He will also supervise the work of the graduate students. Dr. Corman's salary for the academic year is $102,500.

Co-Principal Investigator – Dr. Antony Roberto will dedicate 3 months per year to the project. Dr. Roberto will head the Persuasion and Strategic Communications team to design and conduct the persuasion experiments and analyze the results. He will also support subject recruiting and qualification. Dr. Roberto's salary for the academic year is $85,000.

Co-Principal Investigator – Dr. Gene Brewer will dedicate 3 months per year to the project. He will lead the neuropsychology and neuroimaging team to design and conduct the neuroimaging experiments and analyze the results. Dr. Brewer's salary for the academic year is $75,000.

Co-Principal Investigator – Dr. Angela Trethewey will dedicate 2 months per year to the project. Dr. Trethewey will contribute her expertise supporting the Narrative Theory team. Dr. Trethewey's salary for the academic year is $103,286.

Co-Principal Investigator – Dr. Adam Cohen will dedicate 2 months per year to the project. He will support the neuropsychology and strategic communication teams, and lead subject recruiting and qualification. Dr. Cohen's salary for the academic year is $83,000.

Co-Principal Investigator – Dr. Scott Ruston will dedicate 6 months to the project per year. He will lead the Narrative Theory Team and direct stimulus production area. Dr. Ruston's salary for the fiscal year is $60,000.

Co-Investigator – Dr. Daniel Cutrara will dedicate 1 month in years 1 and 2. He will support the Narrative Theory team in stimulus production area by assisting with storyboard development and screenwriting. Dr. Cutrara's salary for the academic year is $68,000.

Co-Investigator – Dr. Jeffry Halverson will dedicate 0.6 months of his time to the project for Phase 1 and 2. He will contribute his religious studies expertise and his language skills supporting the Narrative Theory group. Dr. Halverson's salary for the fiscal year is $60,000.

Postdoctoral Associates (TBD) - The budget includes funds to hire two full time postdoctoral associates. These positions are primarily targeted at particular tasks; however since the tasks are integrated, both of them will support other tasks as needed. Position 1 will be a candidate with background in Psychology, specializing in Neuropsychology, and will primarily support all three phases. The salary is $60,000 annually. Position 2 will be a candidate with background in Human Communication, specializing in persuasion and social influence, and will primarily support all three phases. The salary is $50,000 annually.

Program Manager (TBD) – The program manager will dedicate 12 months per year to this project. This full time position will coordinate activities of the grant team and act as liaison with the DARPA program officer. Duties will include conducting searches/interviewing, scheduling and managing team meetings, scheduling working hours and monitoring effort of research assistants, coordinating project reviews, helping prepare publications, and filing progress reports as required by DARPA. The salary is $65,000 annually.

Graduate Research Assistants (TBD) - Five full-time Graduate Research Assistants (RAs) will be hired the RAs will primarily support one task but will support other tasks as needed. Two Ph.D. level RAs will primarily support Video and graphic production in Phase 1. Another three Ph.D. level RAs will support research and analysis in all three phases.

Undergraduate Research Assistants - 4 undergraduate students will be hired for working 10 hours per week for 8 months in Phase 1 to support video and graphic production and edition.

Escalation Factor – ASU uses a 3% escalation factor for salaries for each year of the project.

Employee Related Expenses (Fringe Benefits) – Fringe benefits are calculated with rates approved by the University's cognizant federal agency, the Department of Health and Human Services.

Faculty Benefits	33.20%	34.20%	35.23%	36.28%	37.37%
Staff Benefits - 50% or more	44.70%	46.04%	47.42%	48.84%	50.31%
Post Doctoral Associate	44.70%	46.04%	47.42%	48.84%	50.31%
Graduate Student Benefits	10.60%	10.92%	11.25%	11.59%	11.93%
Undergraduate Student Benefits	2.10%	2.16%	2.22%	2.29%	2.36%

Travel

This funding is to support the travel to attend the Program Kickoff Meeting, 2 annual PI meetings and to attend scholarly conferences to disseminate our conceptual framework and research results to peer researchers, and receive feedback for ongoing project efforts. The Human Brain Mapping Conference is dedicated to neuroimaging research and our project team will benefit by having criticism and advice from other experts in the field. Also, our Narrative Team and Strategic Communication Team will attend International Conference on Narrative and the International Communication Association Conference to present our developments in narrative theory and results of persuasion research. The Neuropsychology Team will attend the Annual Meeting of the Psychonomic Society, Society of Experimental Social Psychology Conference, and Society of Personality and Social Psychology to present results and receive feedback related to the social cognition aspects of the project.

Consultants

Story Editor - A professional story editor is needed for the video production team to have a successful creation of an engaging and absorbing narrative on film. The story editor will work 160 hours in year 1 and 80 hours in year 2 at a rate of $250 per hour.

Talent - 2 voiceover and 2 live action talents will be needed to provide expertise in a variety of areas. Low quality voice-over will destroy careful screenwriting; unconvincing acting will disrupt narrative transportation and character identification. They will provide voice-over and live action acting services to help create engaging narrative stimuli materials to ensure successful research. Their contribution is an important part of Phase 1. The voiceover and talents will be compensated $250 per hour for a total of 160 hours during year 1.

Equipment

The MAGLINK system is a critical piece of equipment for allowing simultaneous EEG and fMRI recording in a magnetic field during Phases 1 and 2. This equipment is required to take multimodal (EEG+fMRI) recordings while participants are viewing narratives ($53,120).

The **Magstim TMS system** is a critical piece of equipment for Phase 3 in order to disrupt neural processing through magnetic nerve stimulation. This will provide strong tests of the functioning of the neural networks as described in the technical approach **(**$151,796).

Video production and editing bundles - The video production equipment is needed to document the subjects ' scanning and responses to research equipment. Editing

equipment enables the team to gather useful visual image to document the project and allow researchers to perform analysis ($27,355).

Computers - In phase 1 4 Dell OptiPlex 990 FLX-HD MiniTower Flexible Computing Stations will be purchased. These computers will be solely dedicated to the project and will be used for data accumulation and analysis. Currently, the use of computing stations at Hugh Downs School of Human Communication have been maximized and we do not have the capability to use them as a teaching tool and for sponsored research. ($21,904).

Participant Subject payment

There will be 2 sets of Participant Subject payments

Participants in fMRI testing – Phase 1: 52 subjects (12 for pretest and 40 for actual testing); Phase 2: 160 subjects. Each subject will take a 1.5 hour testing and the subject payment is based on $150 per hour.

Participant in persuasion testing - Phase 1: 320 subjects; Phase 2: 320subjects; and Phase 3:100 subjects. Each subject will receive $20 for the participation.

Subcontract—St. Joseph's Hospital & Medical Center/Barrow Neurological Institute

(Subcontract is for Phases 1 and 2 only)

Co-Principal Investigator Leslie C. Baxter, PhD (10% effort). Funds are requested for Dr. Baxter's salary and benefits to support her efforts on this imaging project. She heads a translational neuroimaging laboratory in the Department of Neuroimaging at Barrow Neurological Institute. Dr. Baxter coordinates imaging and patient-related research for the BNI site. This includes designing and implementing research in functional MRI and other neuroimaging studies. As Program Manager for the Human Brain Imaging Laboratory, she has extensive experience translating complex behavioral designs to functional MRI-compatible paradigms. She will be responsible for designing the fMRI task to be both scientifically and practically robust and repeatable. She will oversee the training of a post-doctoral student in neuroimaging research. She will oversee all aspects of data analysis, including quality control, statistical analyses and manuscript preparation.

Research Assistant (50% effort). Perri Handley is a research assistant who will be responsible for coordinating the daily tasks involved in the imaging project, including assisting with the stimulus setup, coordinating participant related issues with the ASU team, data transfer (FTP) to ASU, and IRB related documentation. Scanning - The Keller Center for Imaging Innovation at the Barrow Neurological Institute at St. Joseph's Hospital and Medical Center is devoted to innovative, state-of-the art imaging research

and development. The Keller Center maintains a 3 Tesla scanner for research purposes and has agreed to support the project schedule as defined in this proposal.

Other - Scans: This funding supports 52 MRI scans for Phase 1 and 160 MRI scans for Phase 2 at the cost of $750/scan (1.5 hr per scan). The Keller Center MRI is a research-devoted MRI that is available both during business hours as well as off-hours, allowing for flexibility of scanning research participants. There is no additional funding needed for stimulus presentation via goggles or headphones, as these are part of the Keller Center equipment, and are kept in working order, with backups, by the Keller Center.

Indirect Costs for BNI – 92% of salaries only

Publication Costs

For each phase, $750 is budgeted for the project team to print posters and hard copy reports for sponsors and conference attendees. This will assist us in more clearly explaining the project and its outcomes. Also, $3000 publication charge per year is budgeted for journals that assess publication fees.

Tuition Remission

This is included as a mandatory benefit for Graduate Students and is charged to sponsored accounts based on the students percentage of effort applied to the research projects. Tuition funds for the academic year are requested at $14,040 for year 1, $15,163 for year 2, $16,376 for year 3, $17,686 for year 4 and $19,101 for year 5. Tuition for the summer year are requested at $914 in year 1, $987 in year 2, $1,066 in year 3, $1,151 in year 4 and $1,243 in year 5.

Facilities and Administration (F&A) Costs

Indirect costs are calculated on Modified Total Direct Costs (MTDC) using F&A rates approved by the Department of Health and Human Services, the current rate for organized research is 52.5%. MTDC is comprised of salaries and wages, fringe benefits, materials and supplies, services, travel and sub grants/subcontracts up to $25,000.